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RESEARCH MEMORANDUM

SURFACE-PRESSURE DISTRIBUTIONS ON A SYSTEMATIC GROUP OF NACA 1-SERIES COWLINGS WITH AND WITHOUT SPINNERS

Ву

Robert W. Boswinkle, Jr., and Arvid L. Keith, Jr.

Langley Field, Va.

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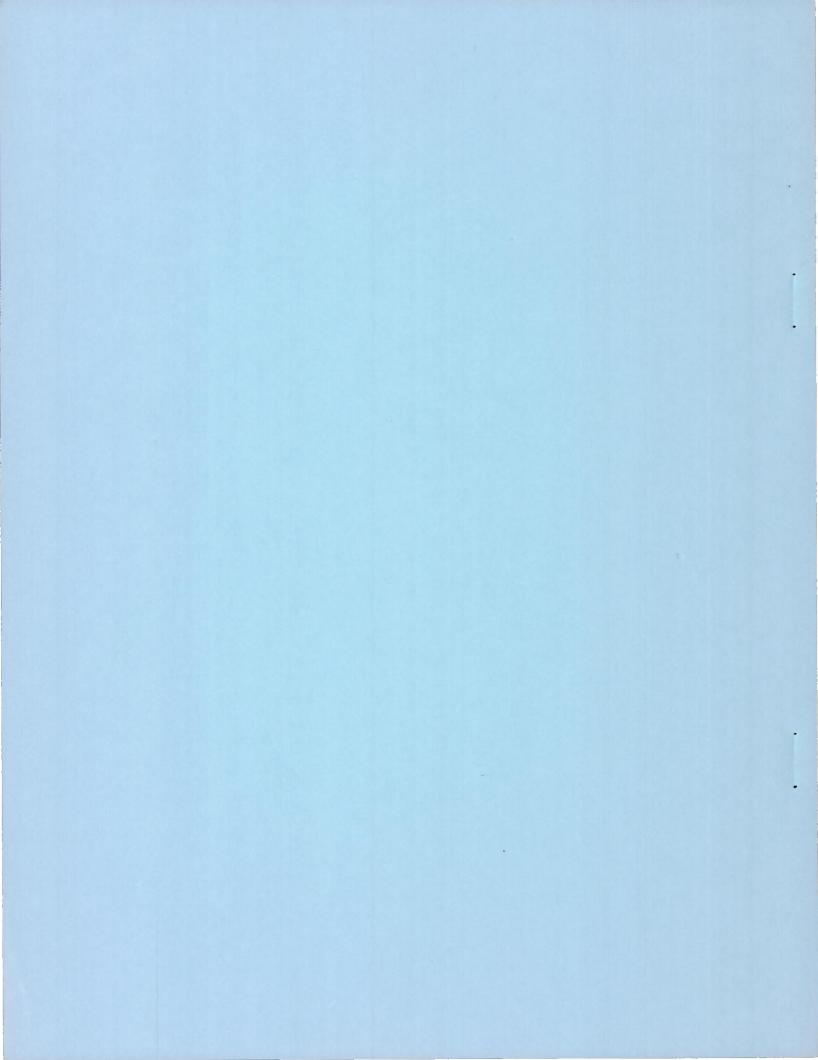
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RESEARCH MEMORANDUM

SURFACE—PRESSURE DISTRIBUTIONS ON A SYSTEMATIC GROUP OF

NACA 1—SERIES COWLINGS WITH AND WITHOUT SPINNERS

By Robert W. Boswinkle, Jr., and Arvid L. Keith, Jr.

SUMMARY

A method for calculating the flow fields of axially symmetric bodies from their pressure distributions is reported in NACA RM No. L8I17. In order to facilitate application of this method to the important case of the cowling-spinner combination, for use in the design of propellers, the present paper presents static-pressure distributions on the tops of 79 highcritical-speed NACA 1-series cowling-spinner combinations over wide ranges of inlet-velocity ratio at angles of attack of 0°, 2°, 4°, and 6°. Staticpressure distributions around the nose sections of several cowlings are given in greater detail to aid in estimating the pressures near the stagnation points and to show the effect of changes in the internal lip shape. The effects of the operation of a typical propeller on the surface pressures on the cowling are shown for one configuration. The pressure distributions over the nine NACA 1-series nose inlets used as the basic components of these combinations are also presented to supplement the existing open-nose-cowling data of NACA ACR No. L5F30a which are applicable to the case of the rotating cowling.

INTRODUCTION

A detailed knowledge of the flow field of the fuselage or nacelle is required in the process of propeller design in order to realize maximum propeller efficiency and, in the case of the cowling-spinner combination, to obtain a high pressure recovery in the cowling inlet. A method for calculating such a flow field from the surface pressures on the body is described in reference 1. Systematic pressure—distribution data for high-critical—speed NACA 1—series nose inlets (which may be used directly as rotating cowlings wherein the forward portions rotate with the propellers) are available in reference 2. The purpose of the present paper is to present similar pressure—distribution data for the 79 high—critical—speed NACA 1—series cowling—spinner combinations investigated in reference 3. Pressure distributions over the nine NACA 1—series nose inlets used as the

basic components of these combinations are included to supplement the data of reference 2.

SYMBOLS AND NOMENCLATURE

đ	cowling inlet diameter (See table I.)
D	maximum cowling diameter
$D_{\mathbf{p}}$	propeller diameter
Ds	maximum spinner diameter (located at cowling inlet)
М	Mach number in undisturbed stream
p	local static pressure
P_{O}	static pressure in undisturbed stream
P	static-pressure coefficient $\left(\frac{p-p_0}{q_0}\right)$
\mathtt{q}_{O}	dynamic pressure in undisturbed stream
T _C	propeller thrust-disk-loading coefficient $\left(\frac{\text{Thrust}}{2q_0D_p^2}\right)$
x	distance from inlet parallel to cowling axis
x ⁸	distance from nose of spinner parallel to cowling axis
X	cowling length, measured from inlet to maximum diameter station
X_s	spinner length measured from spinner nose to maximum diameter station of spinner (which is located at the inlet)
v_i/v_o	inlet-velocity ratio; ratio of average axial velocity of air in inlet to velocity in undisturbed stream
α	angle of attack of model, degrees

The NACA 1-series nose-inlet ordinates and the method of their application to the design of the cowlings and spinners used in the investigation are given in table I. An NACA 1-series cowling-spinner combination having $\frac{d}{D} = 0.70, \frac{X}{D} = 1.00, \frac{D_S}{D} = 0.40, \text{ and } \frac{X_S}{D} = 0.80 \text{ is identified as the}$ NACA 1-70-100 cowling with the NACA 1-40-080 spinner. Thus, in each designation the first term indicates that the NACA 1-series ordinates are used; the second term gives the cowling-inlet diameter or the maximum spinner diameter as a percentage of the maximum cowling diameter; and the third term gives the cowling or spinner length as a percentage of the maximum cowling diameter.

MODEL AND TESTS

The model and instrumentation used in the tests are described in reference 3. The tests were made in the Langley propeller-research tunnel. The nine NACA 1-series cowlings and 11 NACA 1-series spinners investigated are shown in table II. Pressure surveys of each configuration were made with the propeller removed for from 11 to 18 values of inlet-velocity ratio at angles of attack of 0°, 2°, 4°, and 6°. With a 5.7-foot-diameter three-blade propeller of conventional design (reference 3) installed, pressure surveys of one configuration were conducted at angles of attack of 0° and 6° at propeller thrust-disk-loading coefficients of 0.02, 0.06, and 0.12. A tunnel speed of 100 miles per hour, which corresponds to a Mach number of 0.13 and a Reynolds number of about 2×10^6 based on the maximum cowling diameter (27.25 in.), was used for the majority of the tests. For the configurations having very large inlet areas and for all configurations at inlet-velocity ratios above 1.3, the tunnel speed was reduced to 70 miles per hour to obtain the required inlet-velocity ratios with the limited capacity of the internal fan.

DATA

The static-pressure distributions on the tops of the cowling configurations are presented in figures 1 to 88; an index of these figures is given in table III. At zero angle of attack these measured static-pressure distributions are directly applicable to any plane through the axis of symmetry. Check tests showed that these pressure distributions also are almost identical to the pressure distributions on the sides of the cowlings at angles of attack up to about 10°. Further, it may be shown from the experimental data of reference 4 that the pressure distributions on the bottoms of the cowlings at a positive angle of attack may be estimated by extrapolating the pressure-distribution data for the tops at positive angles of attack. Thus, the pressure distribution for the

entire surface of any NACA 1-series cowling-spinner combination within the range of proportions investigated may be obtained at angles of attack from 0° to 6° with acceptable accuracy from the figures of the present report.

Static-pressure distributions around the nose sections of representative NACA 1-series cowlings are given in greater detail in figure 89 to aid in estimating the static pressures near the stagnation point. The effect of a modification to the inner lip shape on the static-pressure distribution around the cowling nose is shown in figure 90. For the purposes of reference 1, it has been found satisfactory to estimate the pressure distributions on the walls of the interior ducting from onedimensional—area considerations.

The effect of propeller operation on the static—and total—pressure distributions on the top of a typical cowling is shown in figures 91 and 92.

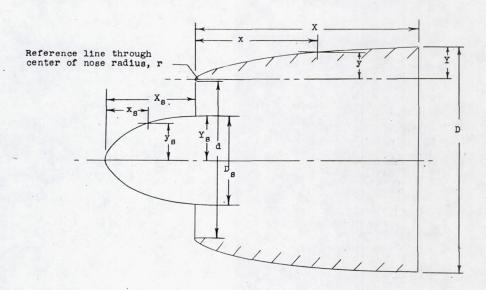
Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va.

REFERENCES

- 1. Boswinkle, Robert W., Jr.: A Method for Calculating Flow Fields of Cowlings with Known Surface—Pressure Distributions. NACA RM No. L8I17, 1948.
- 2. Baals, Donald D., Smith, Norman F., and Wright, John B.: The Development and Application of High-Critical-Speed Nose Inlets. NACA ACR No. L5F30a, 1945.
- 3. Nichols, Mark R., and Keith, Arvid L., Jr.: Investigation of a Systematic Group of NACA 1—Series Cowlings with and without Spinners. NACA RM No. L8A15, 1948.
- 4. Boswinkle, Robert W., Jr.: Air-Flow Surveys in the Vicinity of Representative NACA 1-Series Cowlings. NACA RM No. L8A15a, 1948.

TABLE I

NACA 1-SERIES ORDINATES AS APPLIED TO COWLING AND SPINNER



$$X = \left(\frac{X}{D}\right) D$$

$$Y = \frac{D - d}{2} - 1$$

$$\mathbf{X}_{\mathbf{g}} = \left(\frac{\mathbf{X}_{\mathbf{g}}}{\mathbf{D}}\right) \quad \mathbf{D}$$

$$Y_8 = \frac{D_8}{2} = \frac{\left(\frac{D_8}{D}\right)D}{2}$$

For r = 0.025Y:



$$Y = \frac{D - d}{2.05} = \frac{D\left(1 - \frac{d}{D}\right)}{2.05}$$

[Ordinates in percent; taken from reference 3]

x/X or	y/Y or y _g /Y _g	x/X or x _g /X _g	y/Y or yg/Yg	x/X or x _g /X _g	y/Y or	x/X or	y/Y 01
0 24 66 80 11.50 2.50 5.50 67.00 8.00 9.00 112.0	9 4 80 6 6 8 12 9 10 3 7 8 12 14 5 7 7 7 1 8 1 9 4 8 22 14 6 5 7 1 1 9 4 8 22 29 4 8 1 5 9 4 8 27 31 6 1 7 3 1 7 3 1 6 1 7 3 1 7 3 1 6 1 7 3 1 7 3 1 6 1 7 3 1	13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0	41.946 43.588 445.60 445.638 456.638 456.638 456.638 456.638 456.638 456.638 456.638 456.638 456.638 4	# 000000000000000000000000000000000000	9.08 70.08 71.05 72.00 72.94 73.85 74.75 75.48 77.32 76.48 77.32 78.15 78.55 81.95 81.25 8	860.0 62.0 64.0 668.0 70.0 774.0 780.0 880.0 90.0 90.0 944.0 968.0 100.0	\$9.120 90.20 91.23 92.20 93.17 93.97 96.16 96.75 97.87 97.87 99.98 99.98 99.98 99.98 100.00

Table II.- NACA 1-Series Cowlings and Spinners Tested.

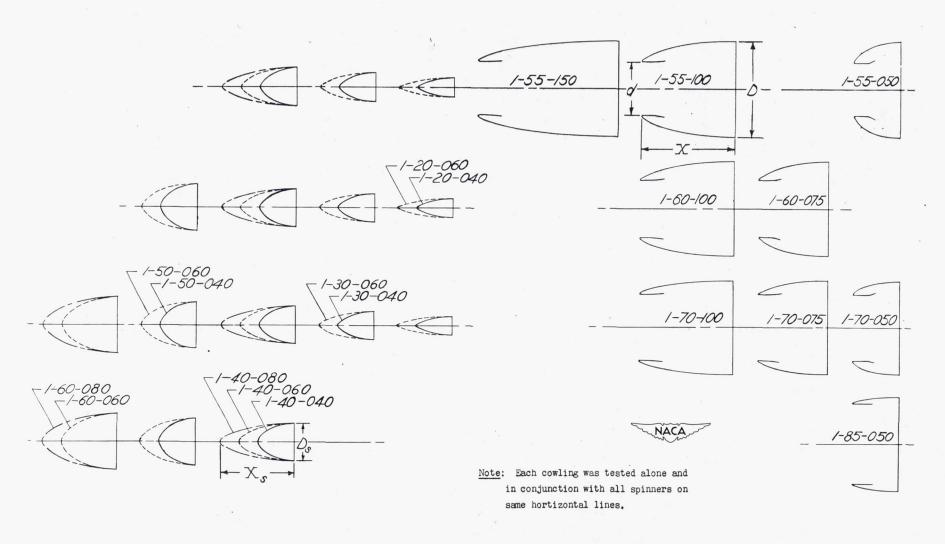


TABLE III.- INDEX TO SURFACE-PRESSURE DISTRIBUTIONS FOR NACA 1-SERIES COWLING-SPINNER COMBINATIONS

AND OPEN-NOSE INLETS									
Figure	Cowling	Spinner	Figure	Cowling	Spinner				
1	1-55-050	No spinner	45	1-70-050	No spinner				
3 4	do	1-20-040	46	do	1-20-040				
3	do	1-30-040	47	do	1-30-040				
	do	1-40-040	48	do	1-40-040				
5	do	1-20-060	49	do	1-50-040				
	do	1-30-060	50	do	1-20-060				
7 8	do	1-40-060	51	do	1-30-060				
	do	1-40-080	52	do	1-40-060				
9	1-55-100	No spinner	53	do	1-50-060				
. 10	do	1-20-040	54	do	1-60-060				
11	do	1-30-040	55	do	1-40-080				
12	do	1-40-040	56	do	1-60-080				
13 14	do	1-20-060	57	1-70-075	No spinner				
	do	1-30-060	58	do	1-20-040				
15	do	1-40-060	59	do	1-30-040				
16	do	1-40-080	60	do	1-40-040				
17	1-55-150	No spinner	61	do	1-50-040				
18	do	1-20-040	62	do	1-20-060				
19	do	1-30-040	63	do	1-30-060				
20	do	1-40-040	64	do	1-40-060				
21	do	1-20-060	65	do	1-50-060				
22	do	1-30-060	. 66	do	1-60-060				
23	do	1-40-060	67	do	1-40-080				
24	do	1-40-080	68	do	1-60-080				
25	1-60-075	No spinner	69	1-70-100	No spinner				
26	do	1-20-040	70	do	1-20-040				
27	do	1-30-040	71	do	1-30-040				
28	do	1-40-040	72	do	1-40-040				
29	do	1-50-040	73	do	1-50-040				
30	do	1-20-060	74	do	1-20-060				
31	do	1-30-060	75	do	1-30-060				
32	do	1-40-060	76	do	1-40-060				
33	do	1-50-060	77	do	1-50-060				
34	do	1-40-080	78	do	1-60-060				
35	1-60-100	No spinner	79	do	1-40-080				
36 37	do	1-20-040	80	do	1-60-080				
37 38	do	1-30-040	81	1-85-050	No spinner				
39		1-40-040	82	do	1-40-040				
40	do	1-50-040	83	do	1-50-040				
41	do	1-20-060	.84	do	1-40-060				
42	do	1-30-060 1-40-060	85	do	1-50-060				
43	do		86	do	1-60-060				
44		1-50-060	87	do	1-40-080				
44	do	1-40-080	88	do	1-60-080				

NACA

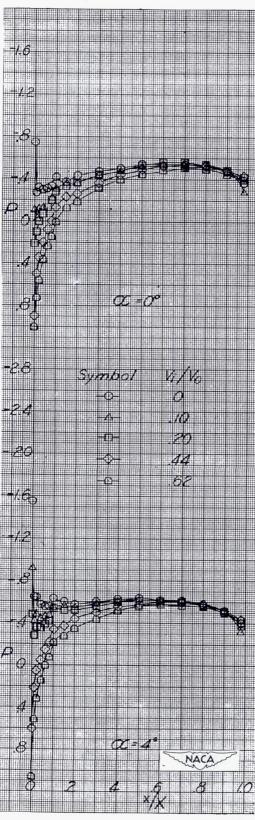


Figure 1.- Static-pressure distributions on top of NACA 1-55-050 open-nose cowling.

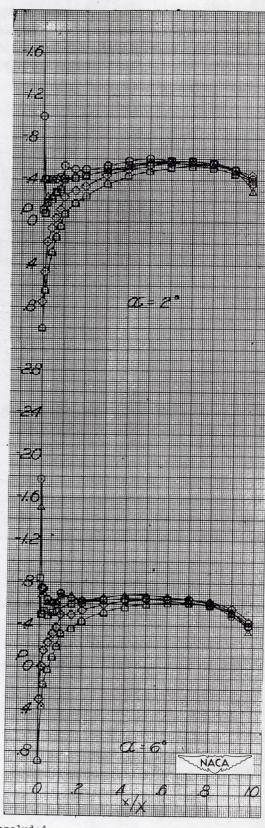


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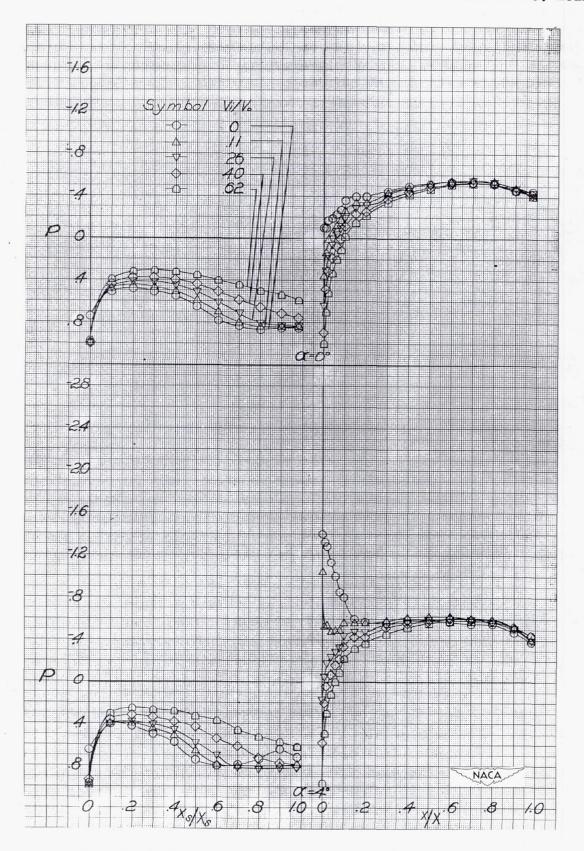


Figure 2.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-20-040 spinner.

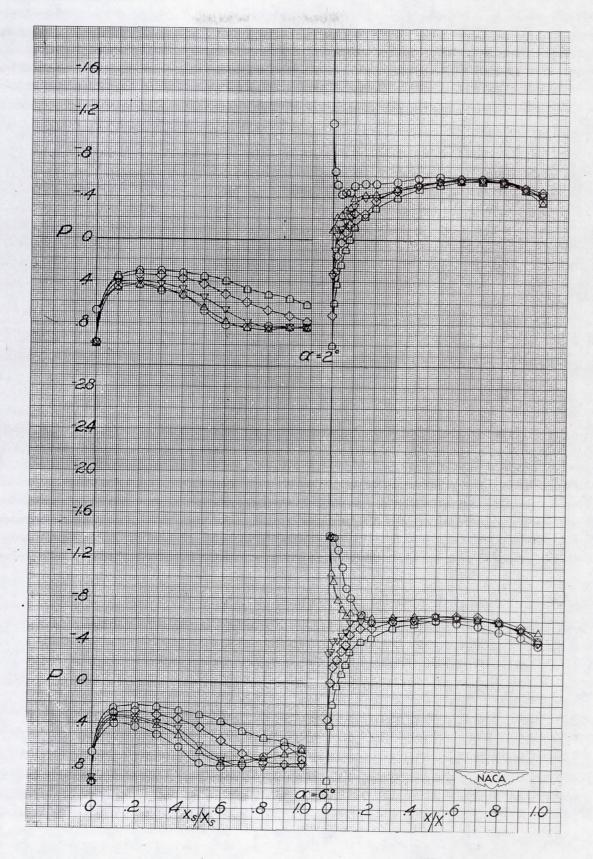


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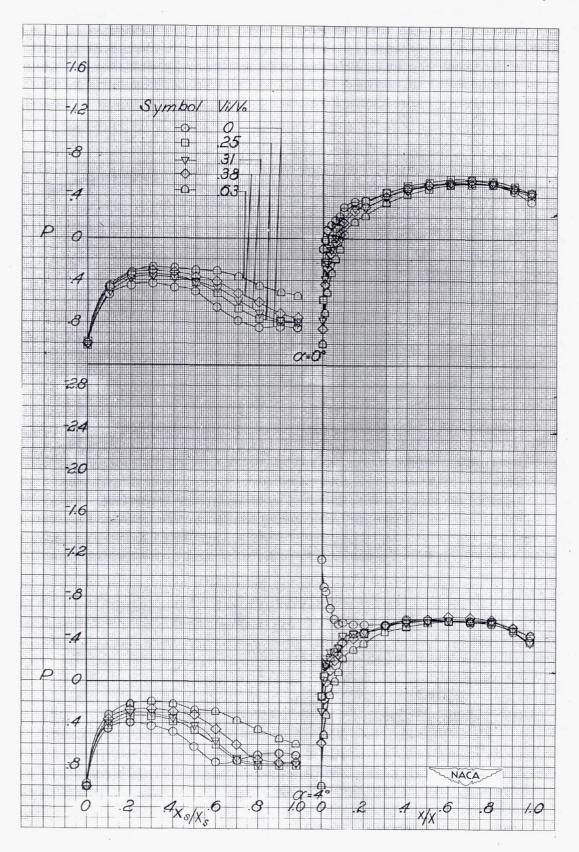


Figure 3.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-30-040 spinner.

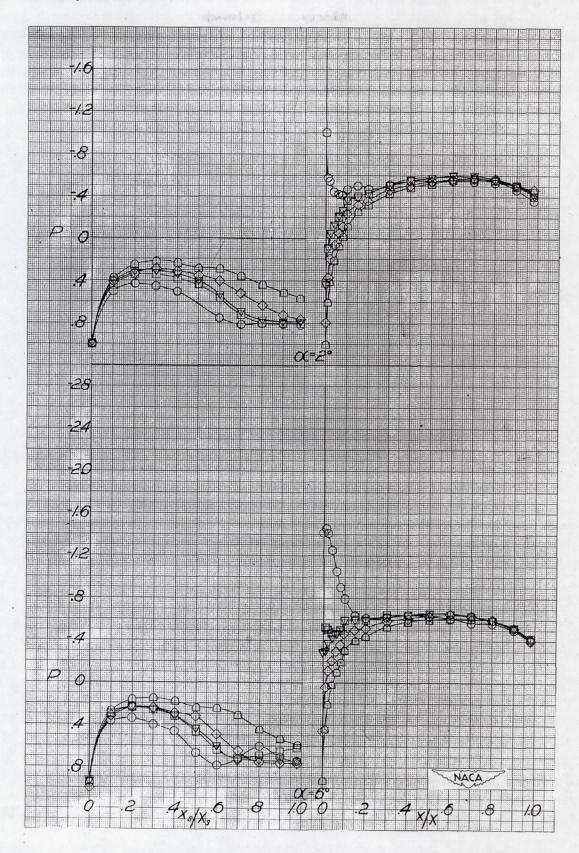


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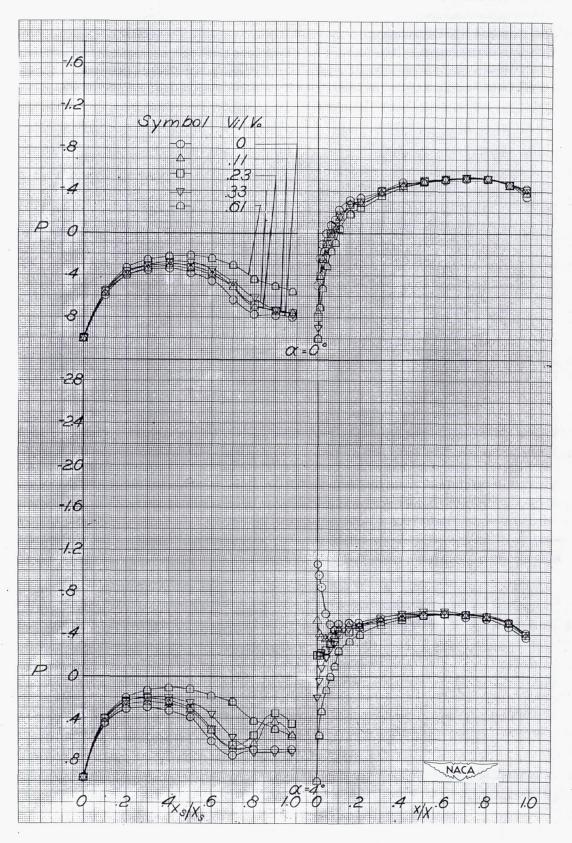


Figure 4.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-40-040 spinner.

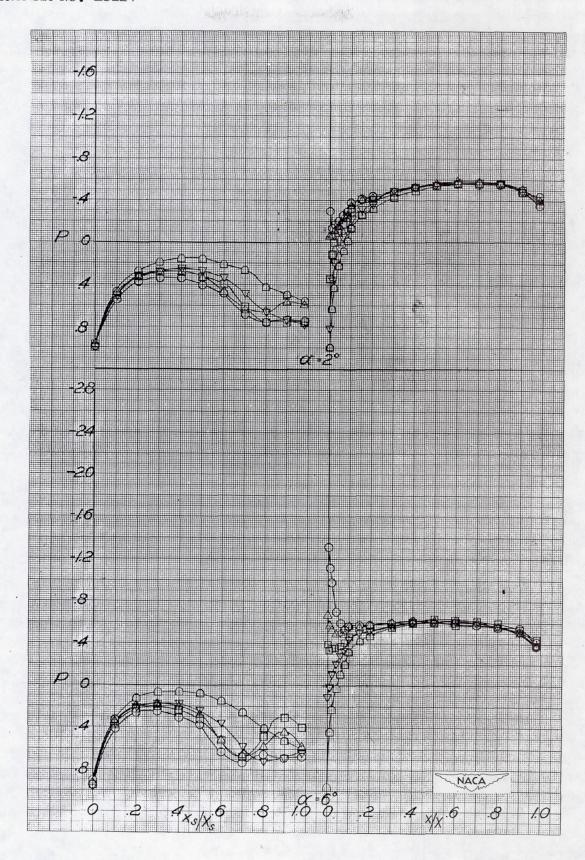


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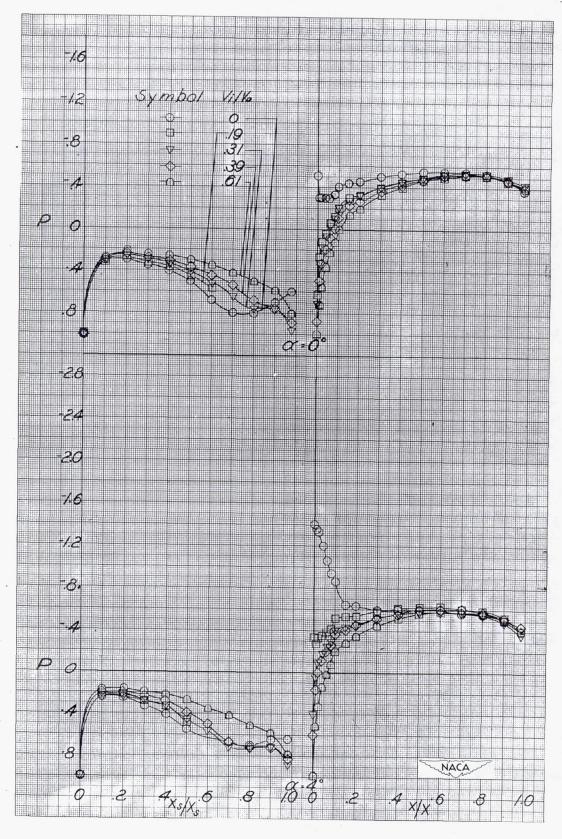


Figure 5.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-20-060 spinner.

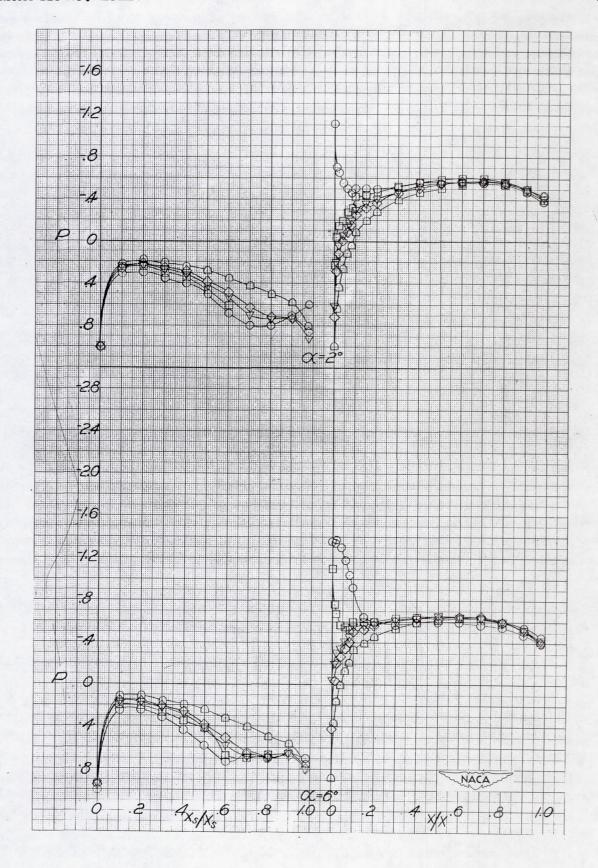


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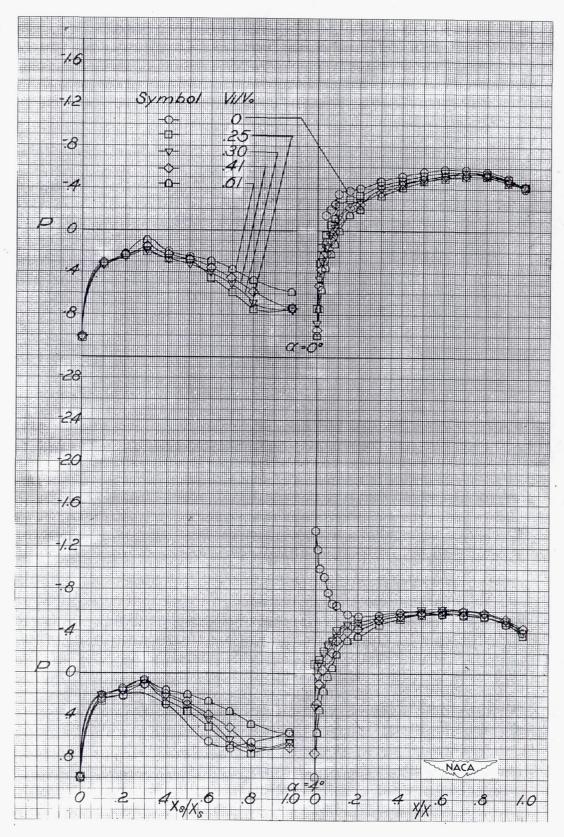


Figure 6.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-30-060 spinner.

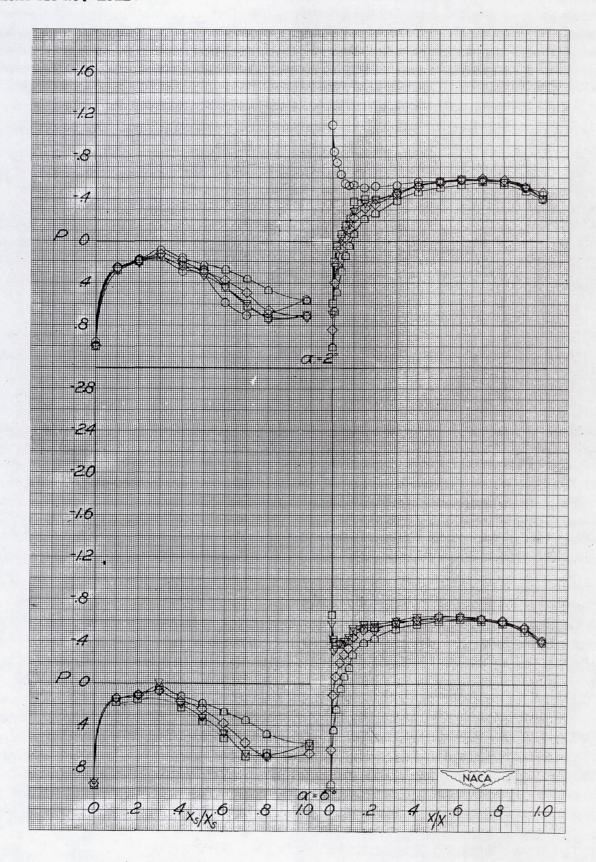


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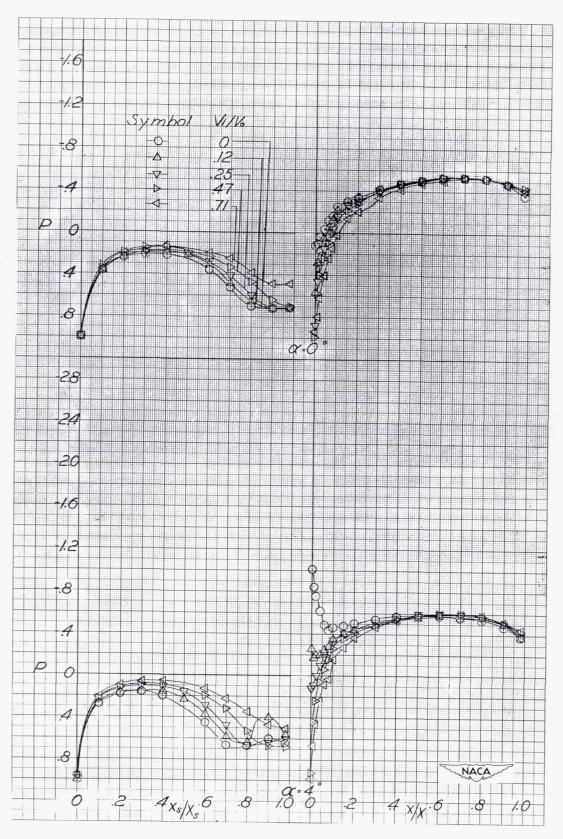


Figure 7.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-40-060 spinner.

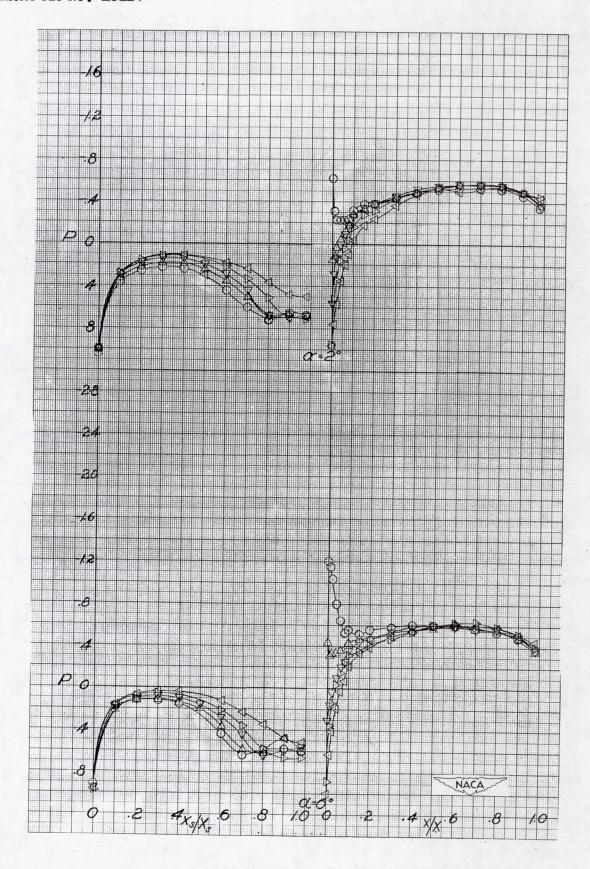


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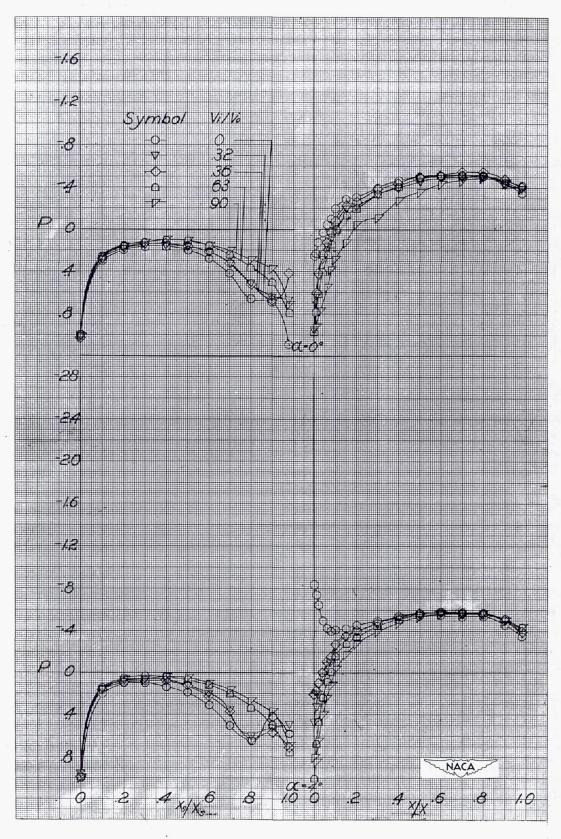


Figure 8.- Static-pressure distributions on top of NACA 1-55-050 cowling with NACA 1-40-080 spinner.

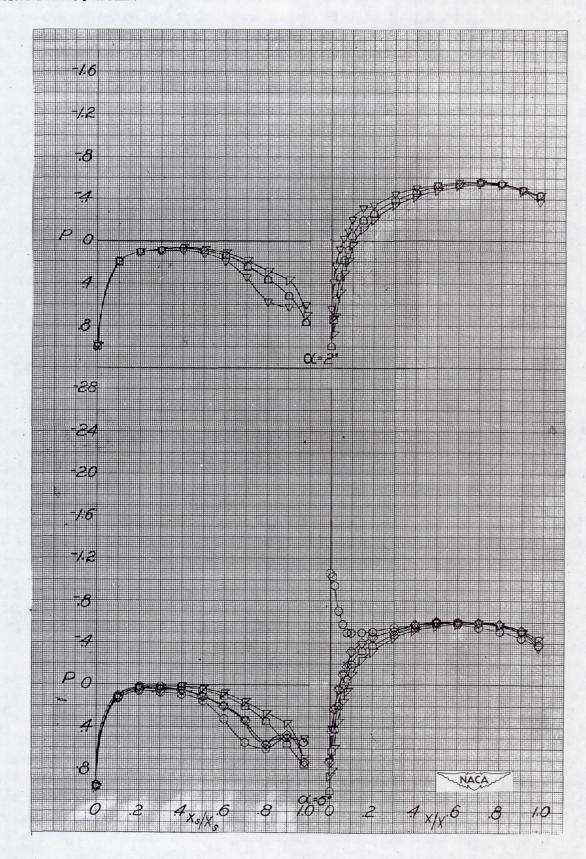


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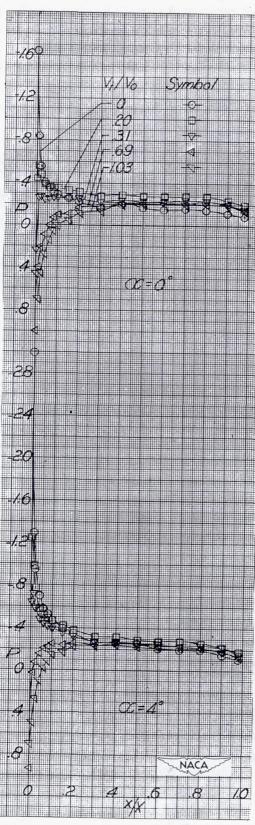


Figure 9.- Static-pressure distributions on top of NACA 1-55-100 open-nose cowling.

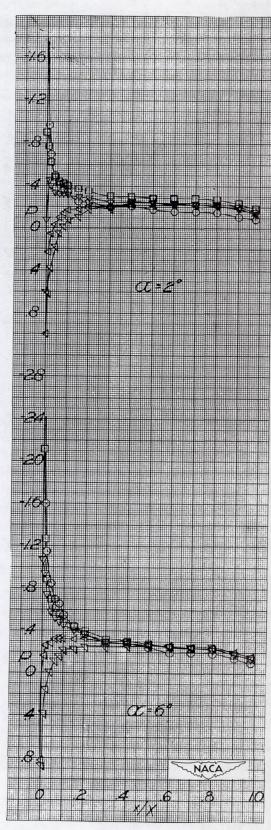


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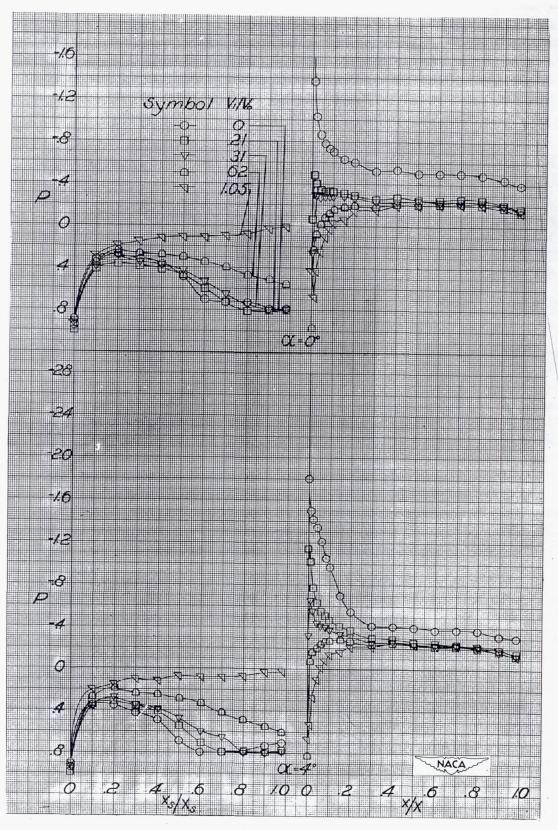


Figure 10.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-20-040 spinner.

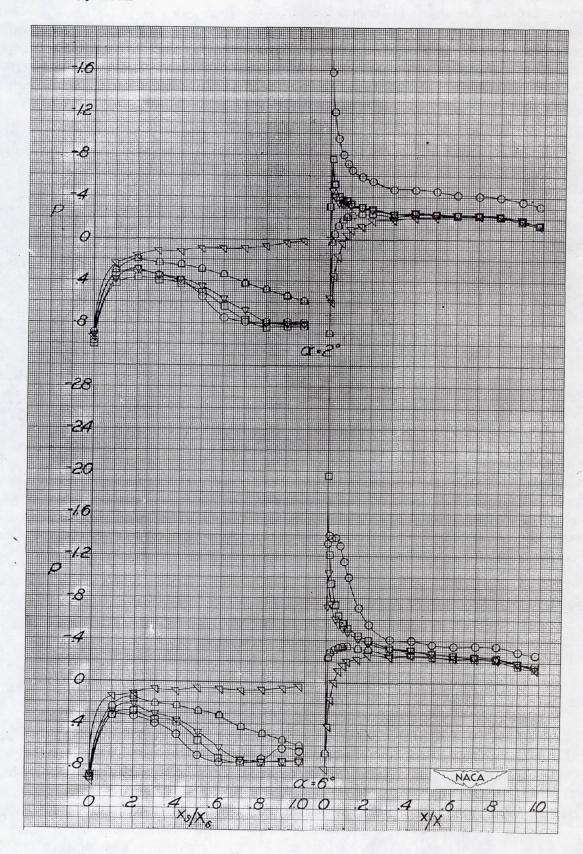


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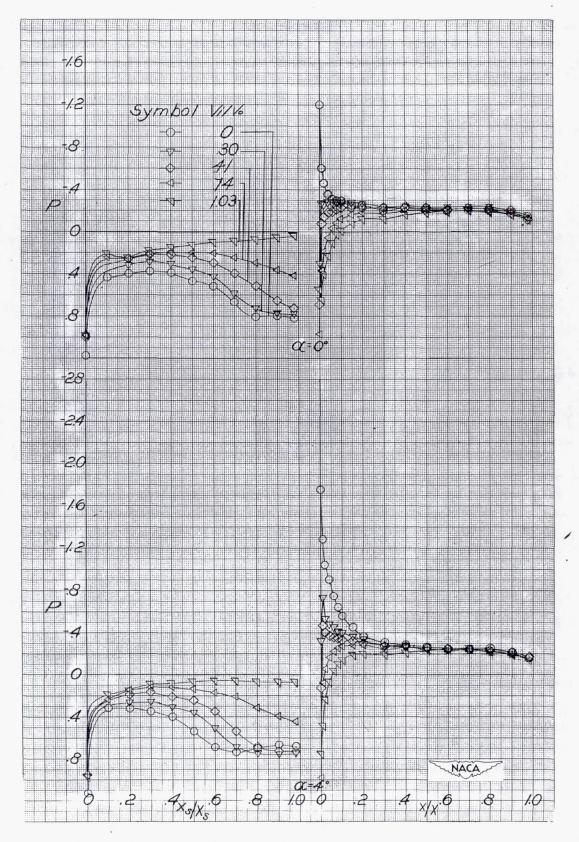


Figure 11.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-30-040 spinner.

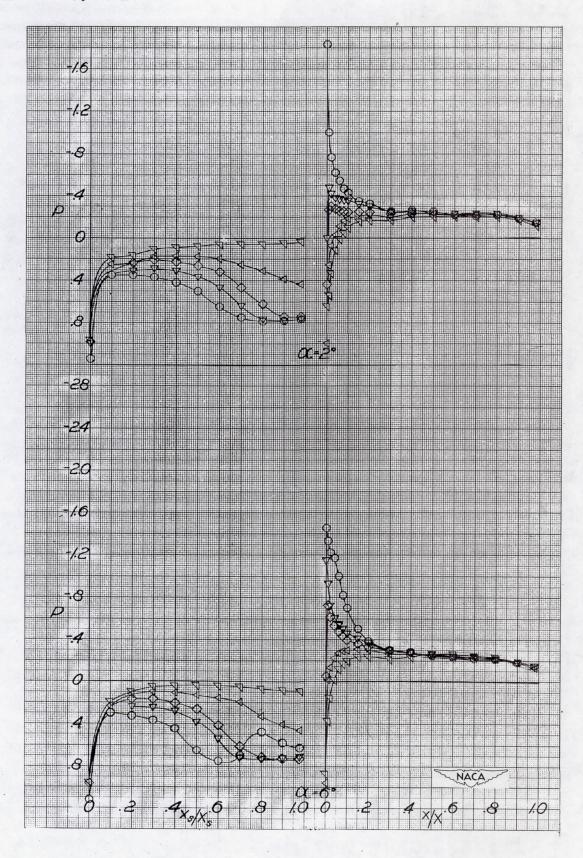


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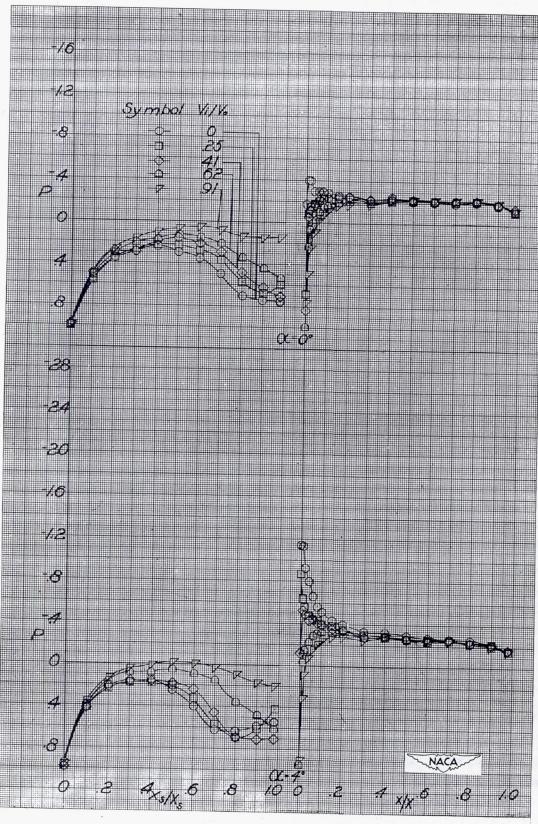


Figure 12.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-40-040 spinner.

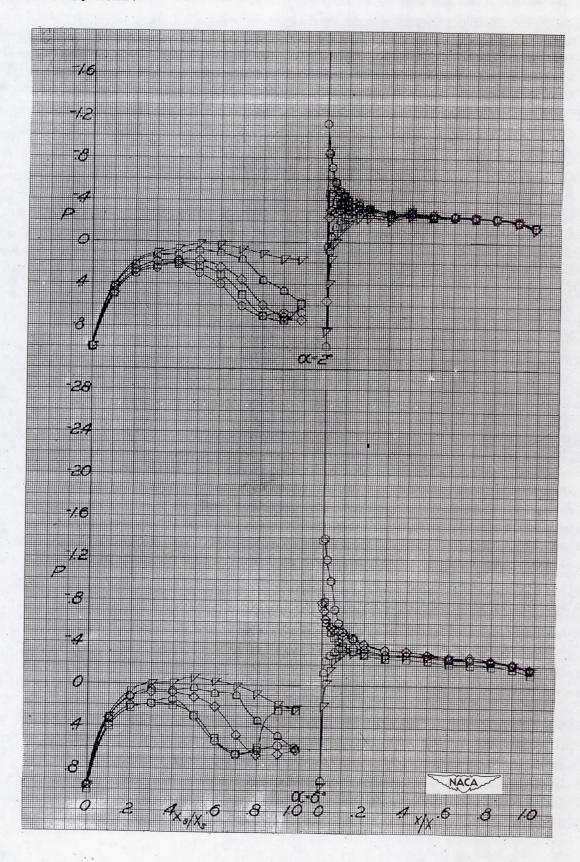


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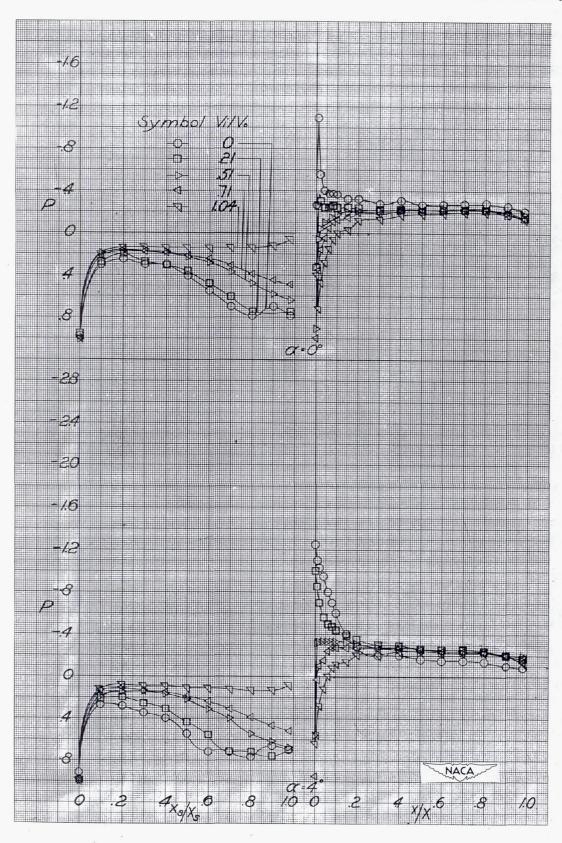


Figure 13.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-20-060 spinner.

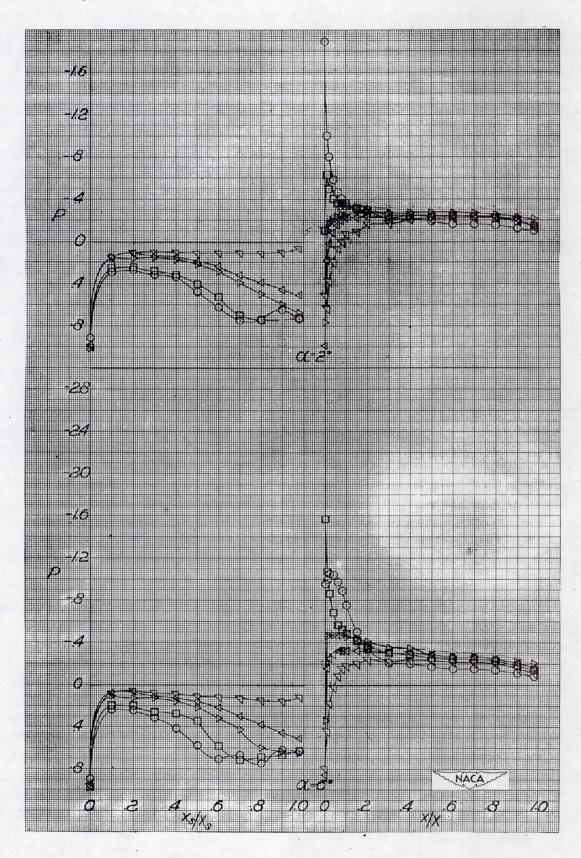


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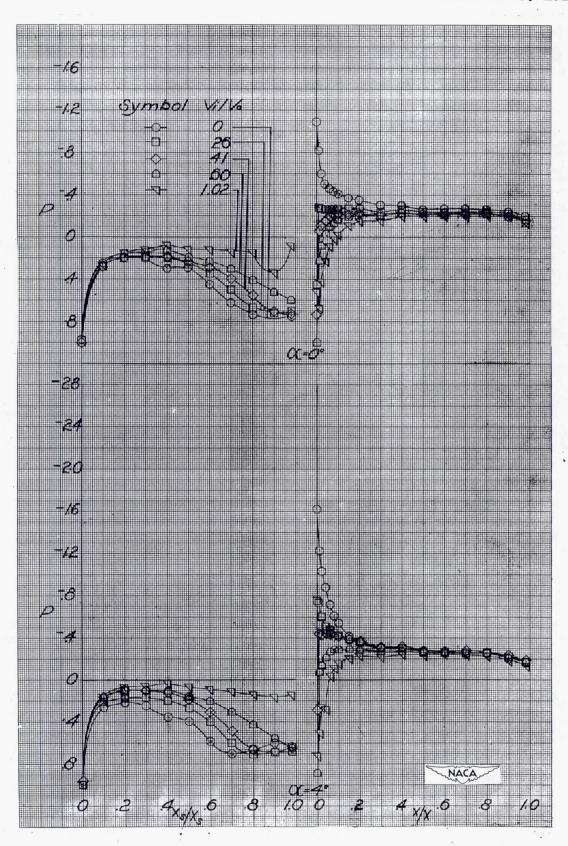


Figure 14.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-30-060 spinner.

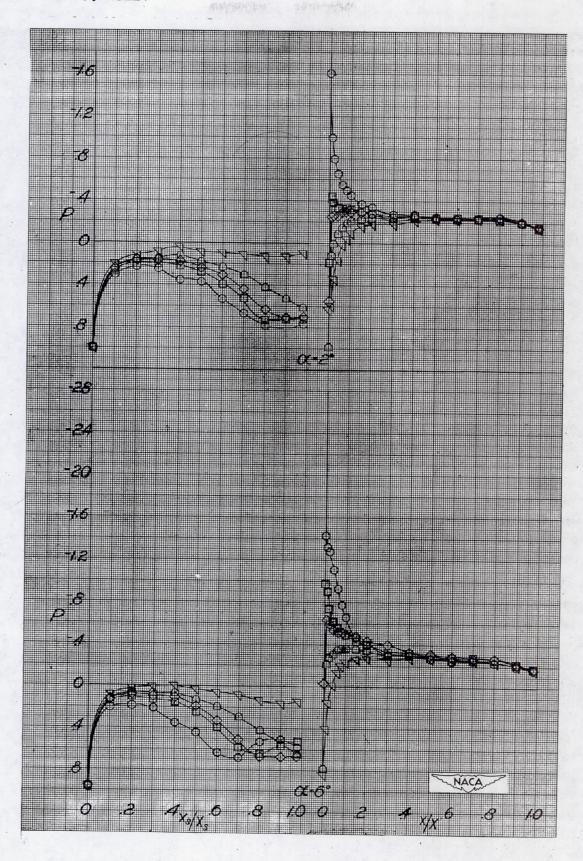


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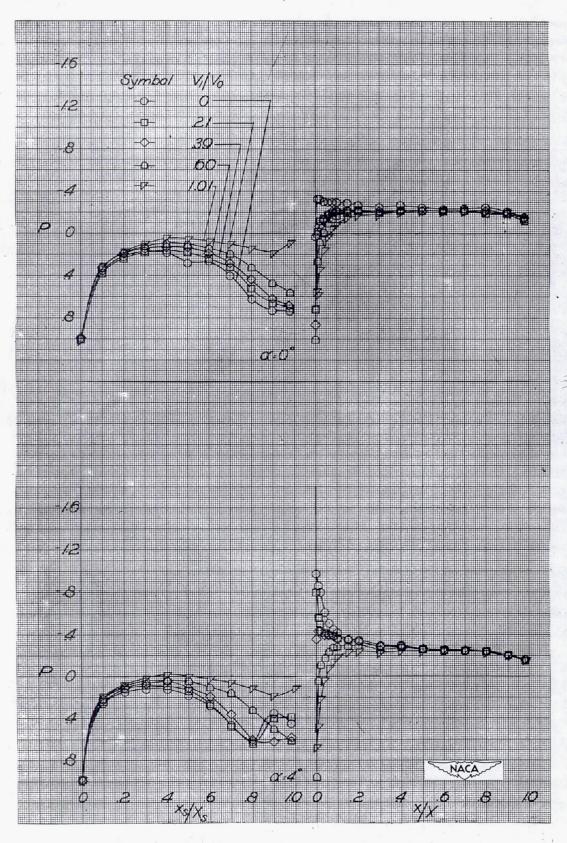


Figure 15.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-40-060 spinner.

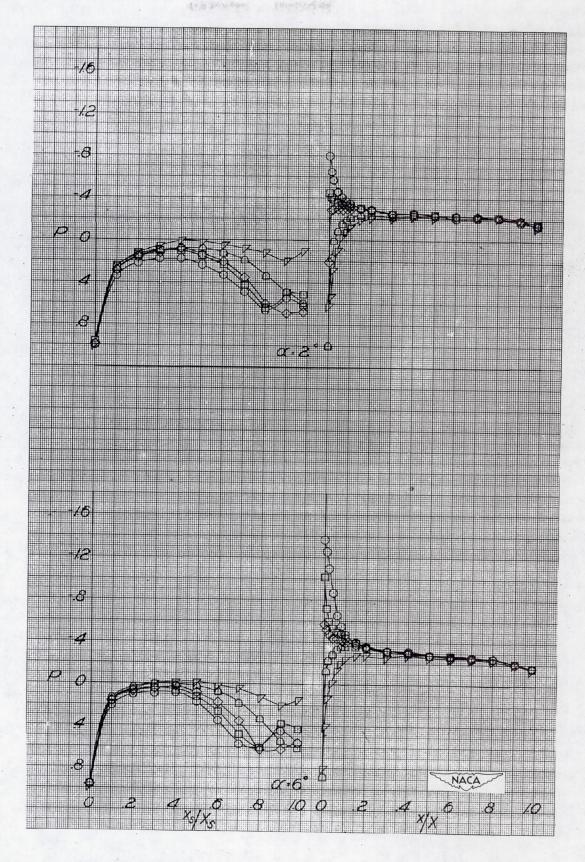


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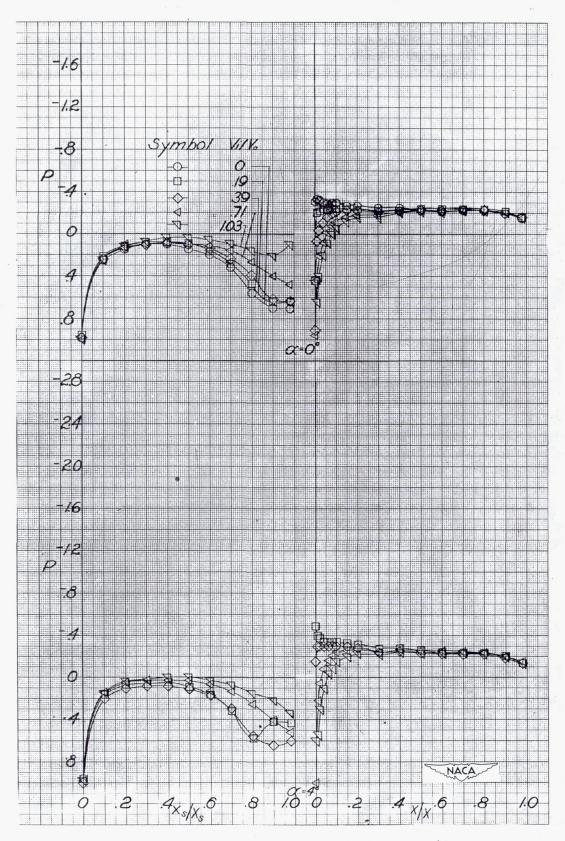


Figure 16.- Static-pressure distributions on top of NACA 1-55-100 cowling with NACA 1-40-080 spinner.

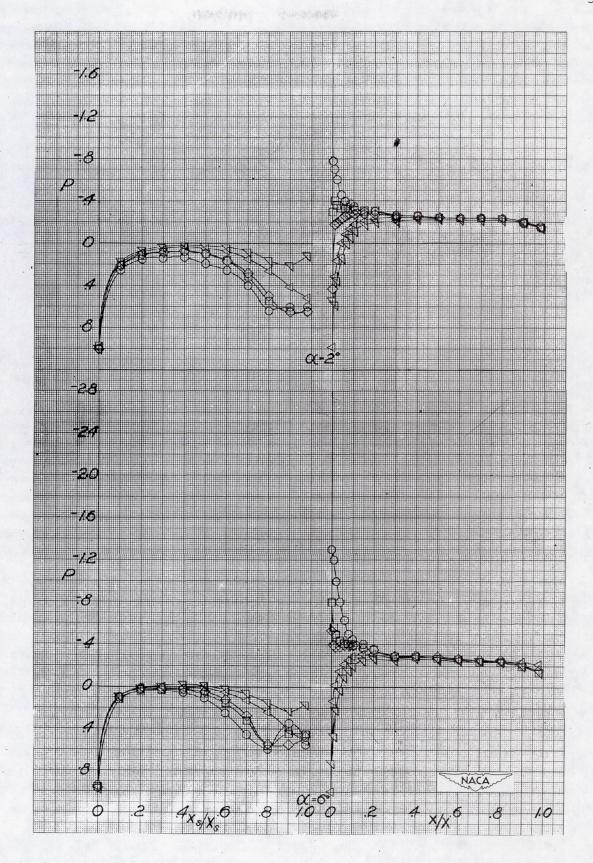


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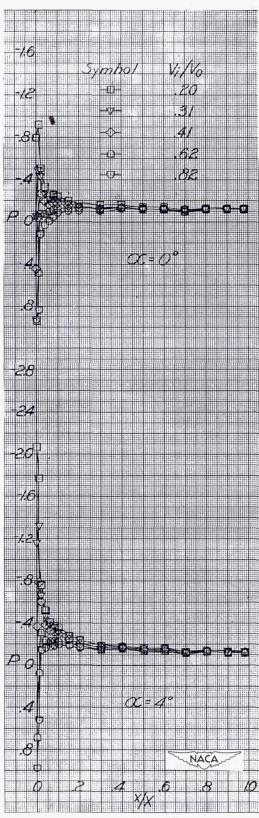


Figure 17.- Static-pressure distributions on top of NACA 1-55-150 open-nose cowling.

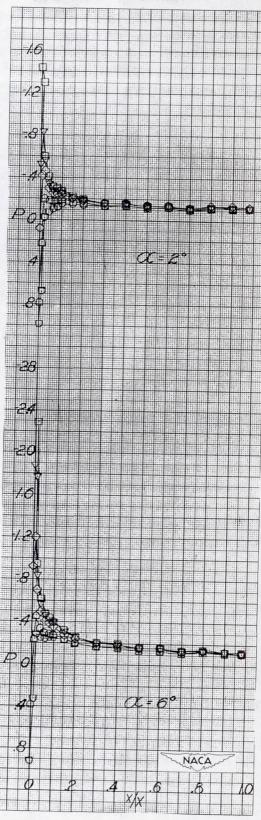


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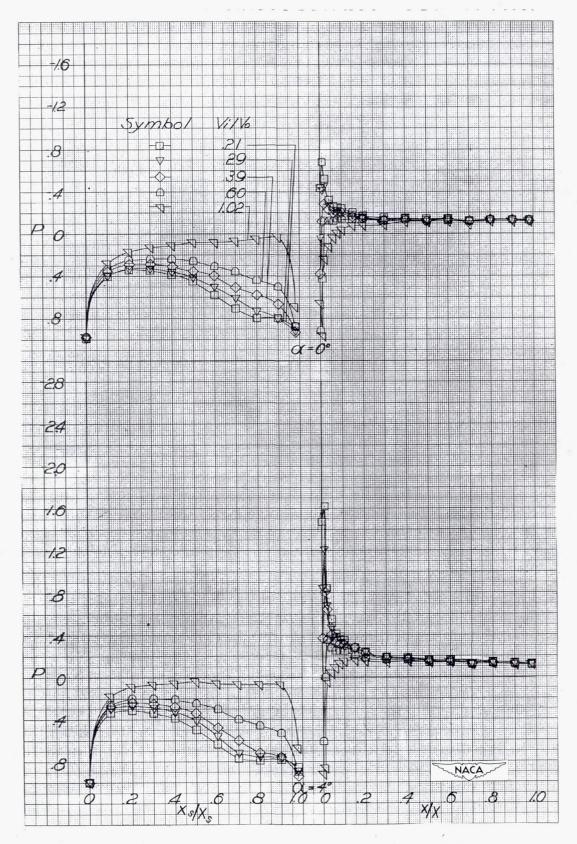


Figure 18.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-20-040 spinner.

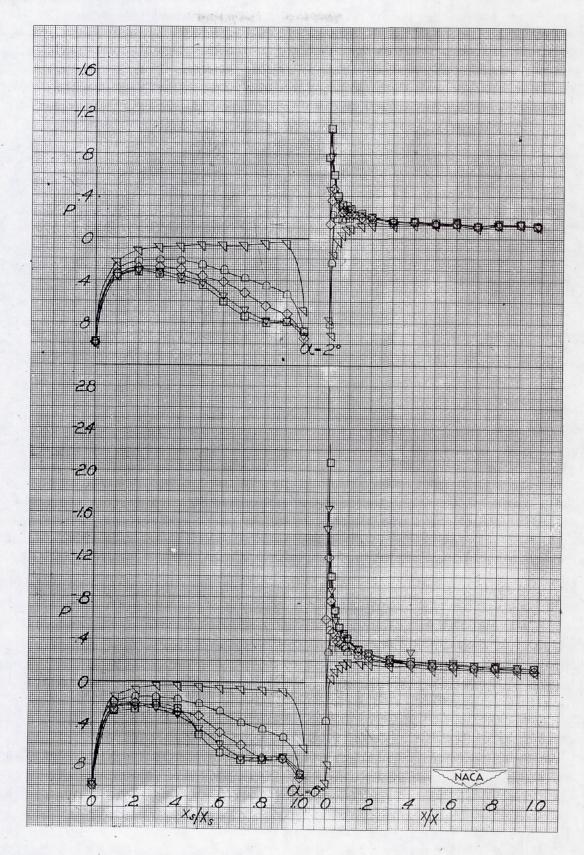


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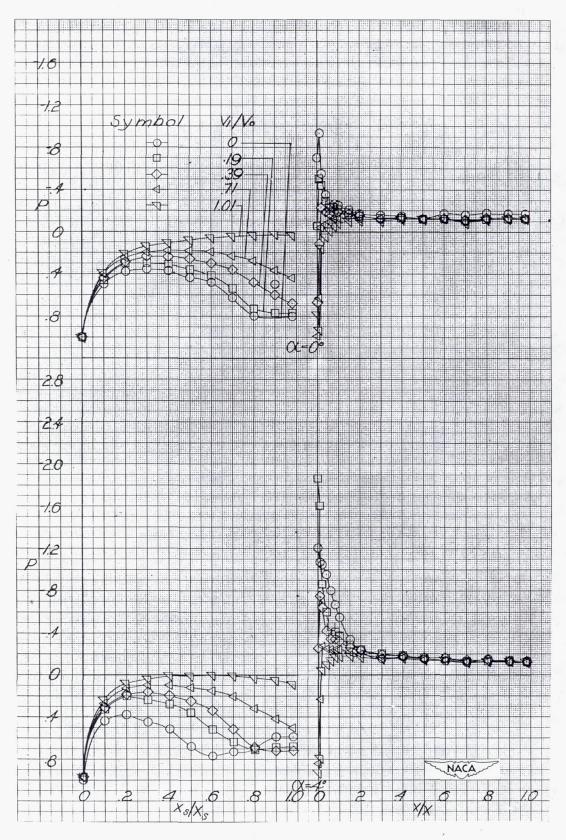


Figure 19.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-30-040 spinner.

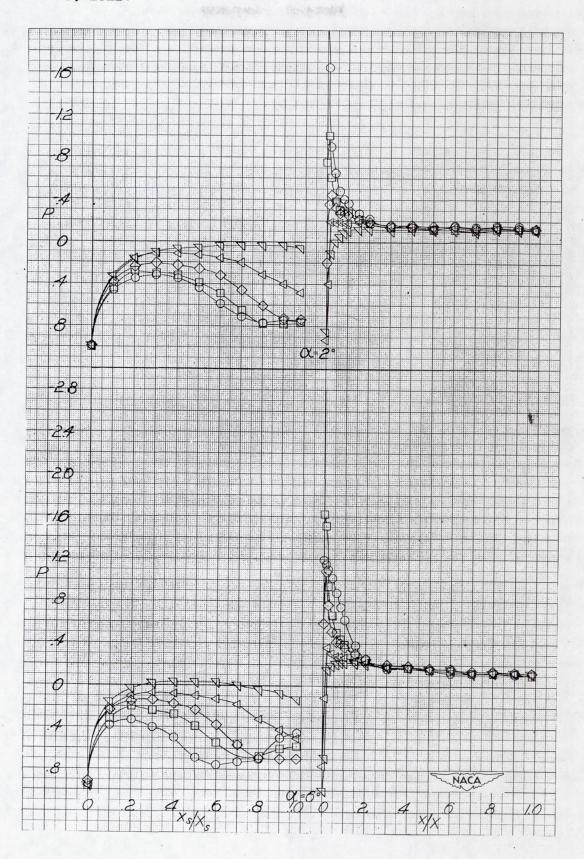


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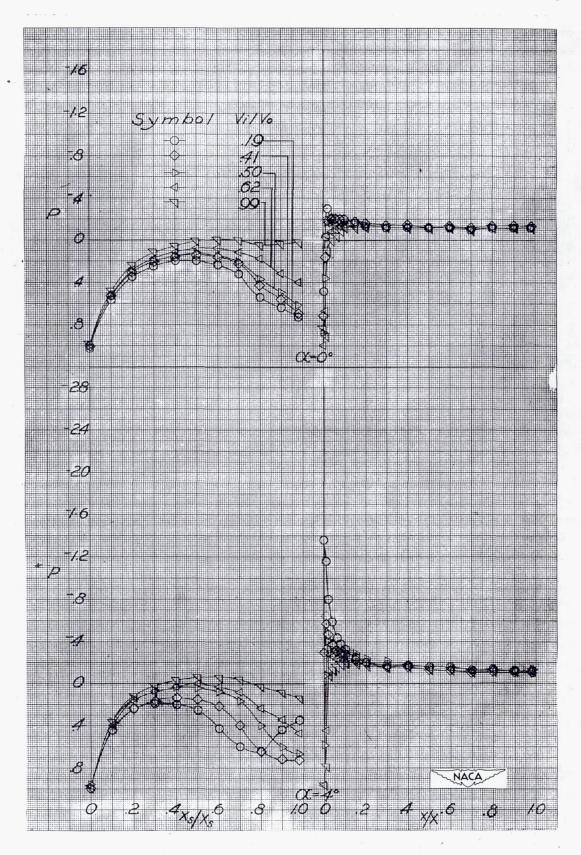


Figure 20.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-40-040 spinner.

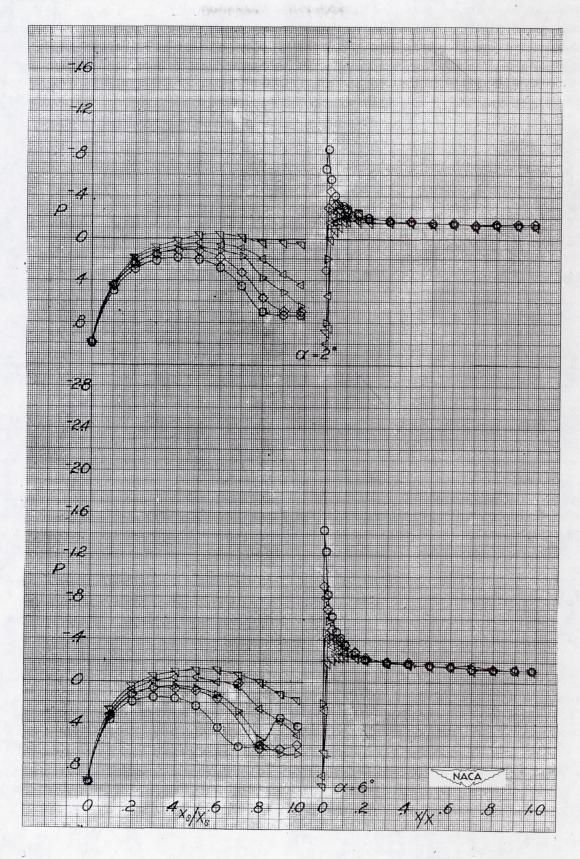


Figure 20.- Concluded.

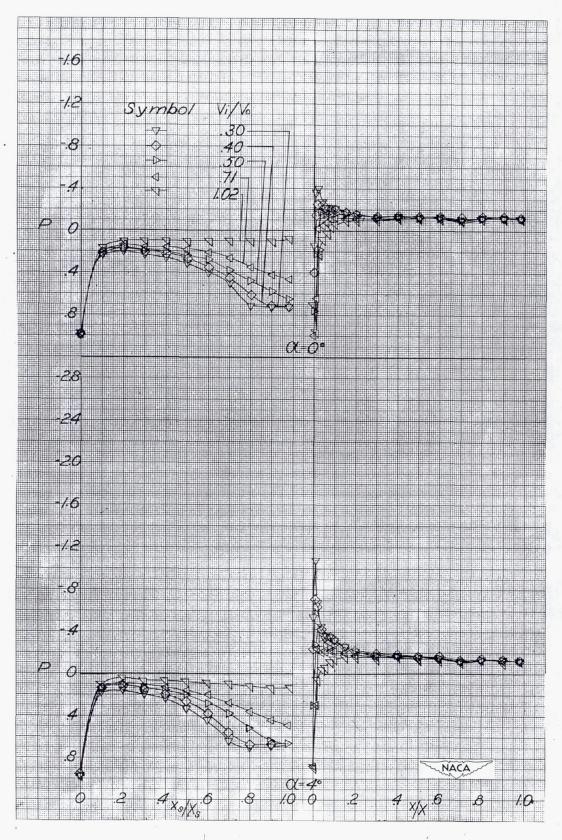


Figure 21.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-20-060 spinner.

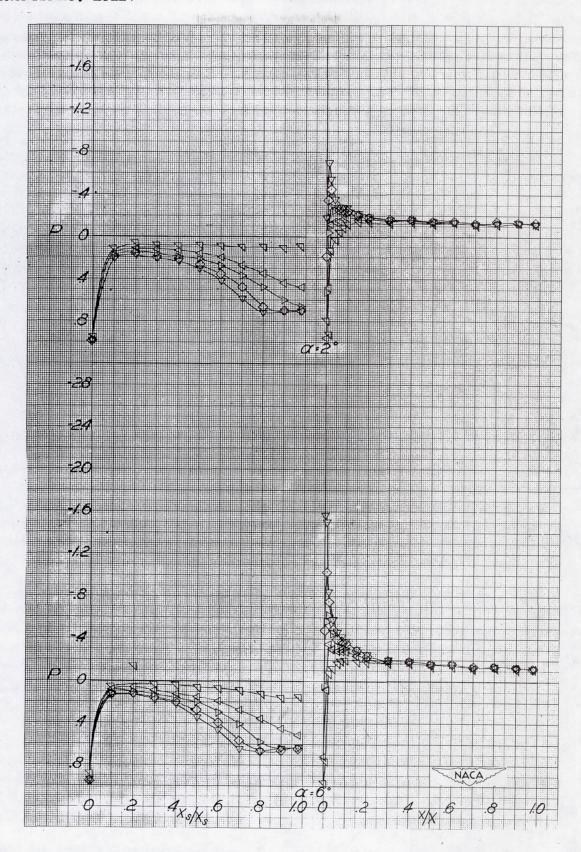


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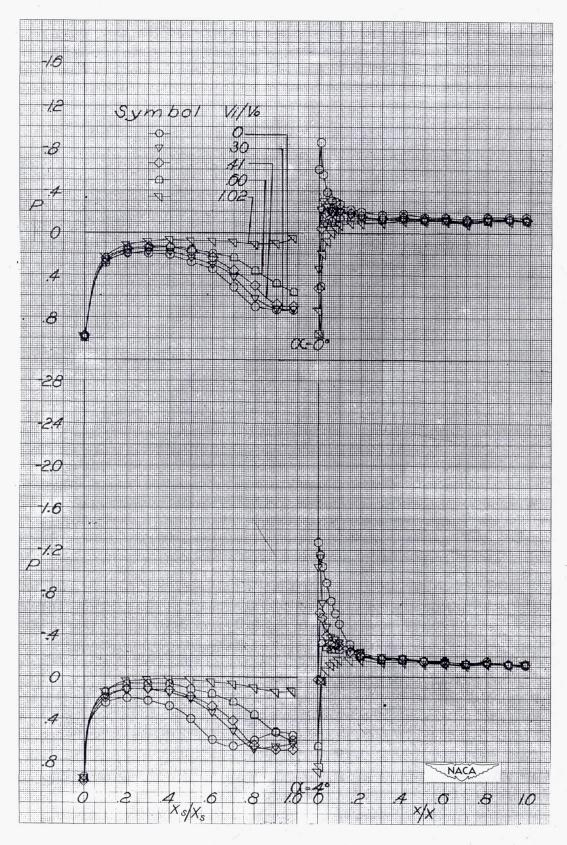


Figure 22.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-30-060 spinner.

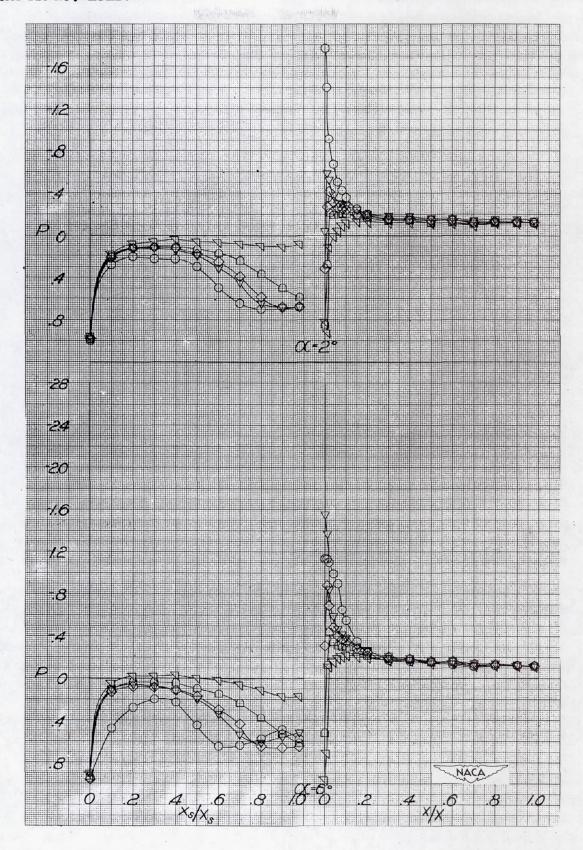


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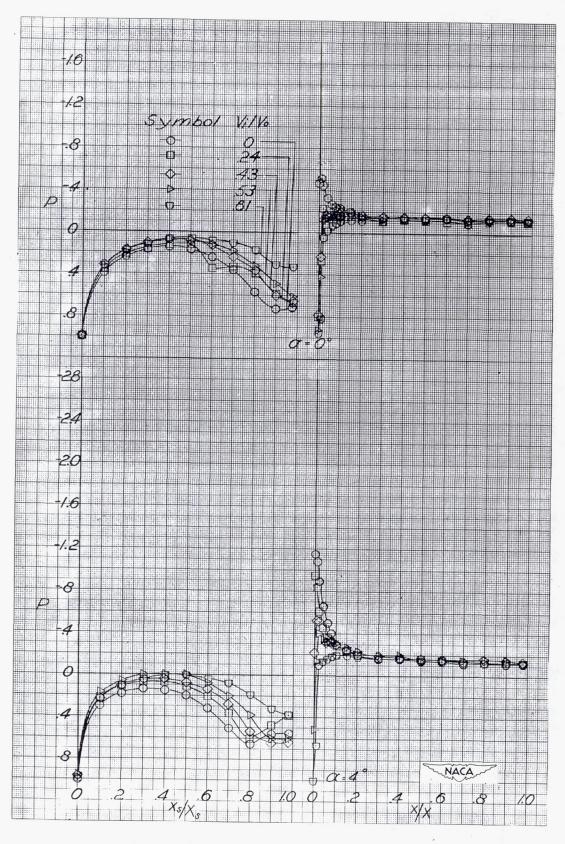


Figure 23.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-40-060 spinner.

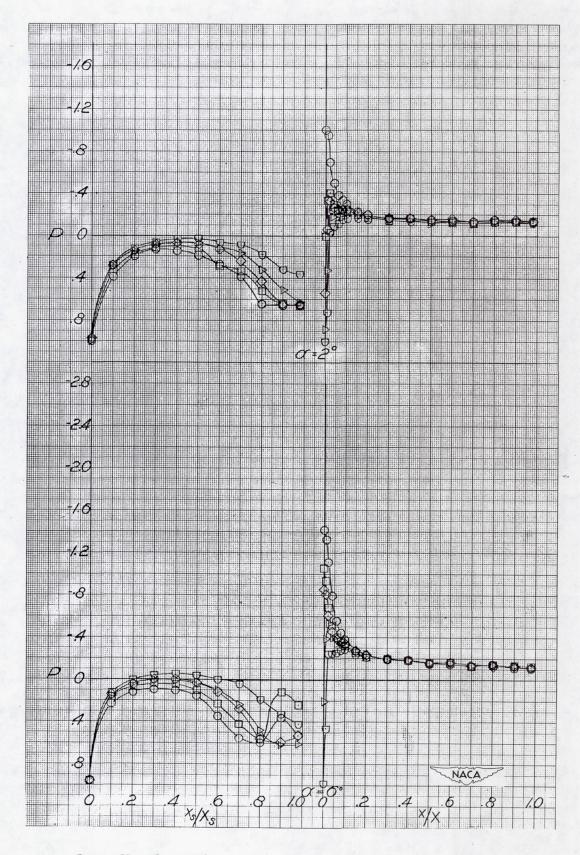


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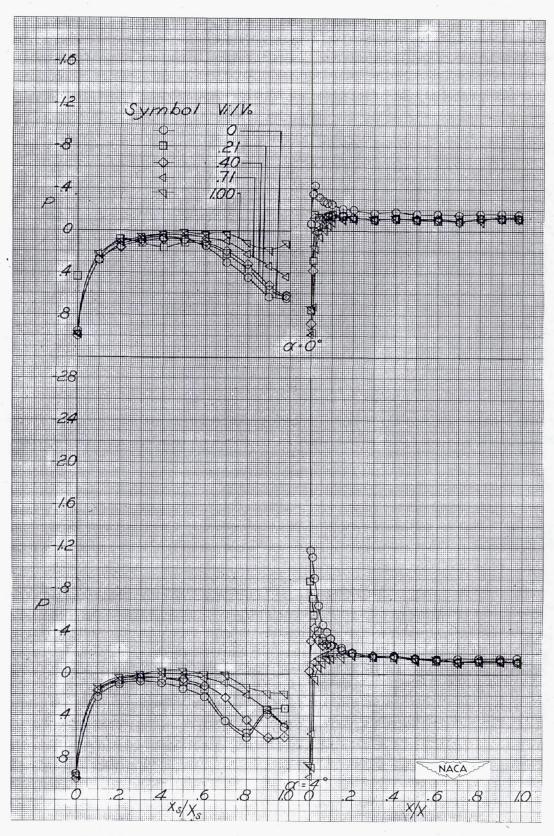


Figure 24.- Static-pressure distributions on top of NACA 1-55-150 cowling with NACA 1-40-080 spinner.

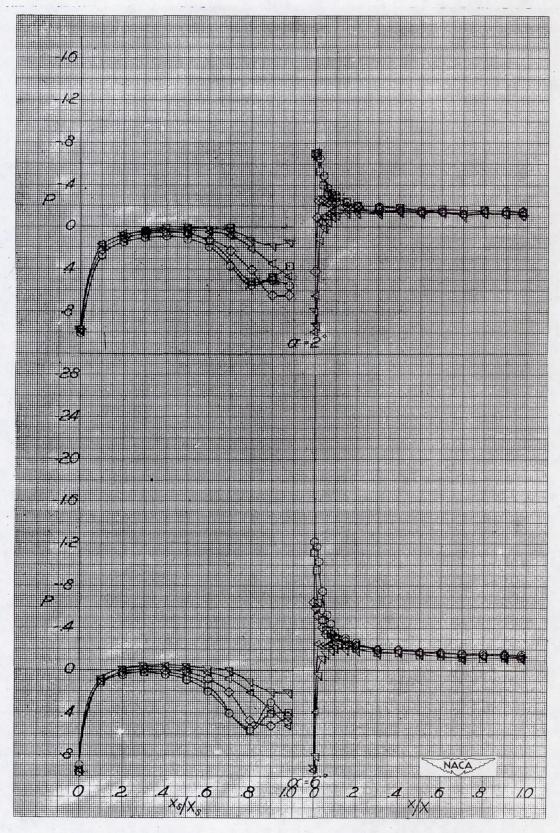


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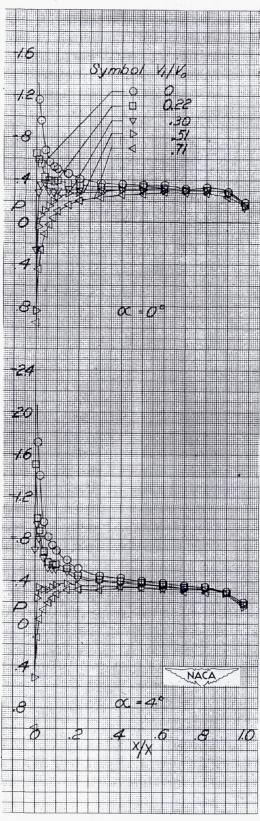


Figure 25.- Static-pressure distributions on top of NACA 1-60-075 open-nose cowling.

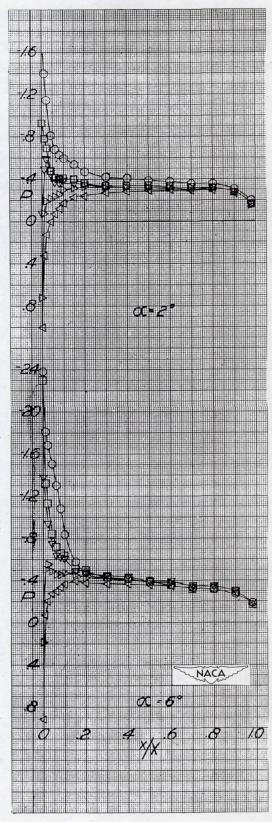


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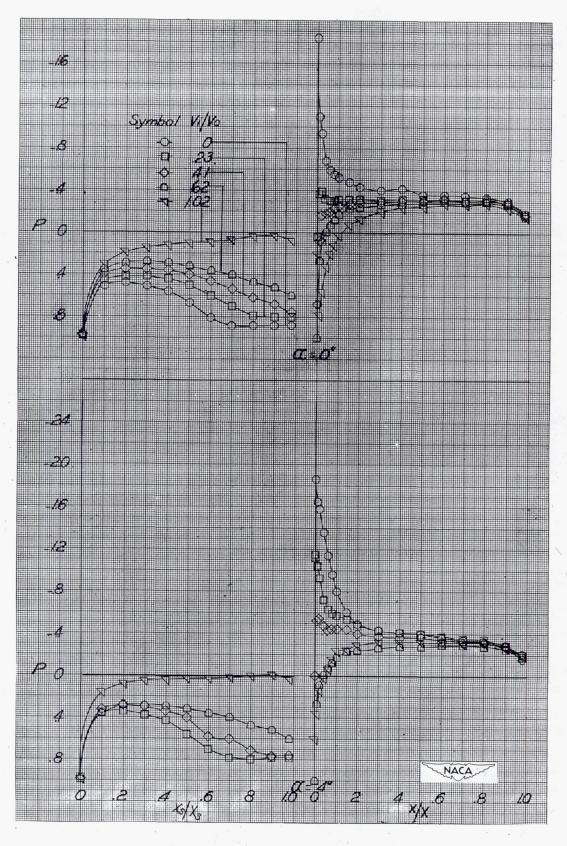


Figure 26.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-20-040 spinner.

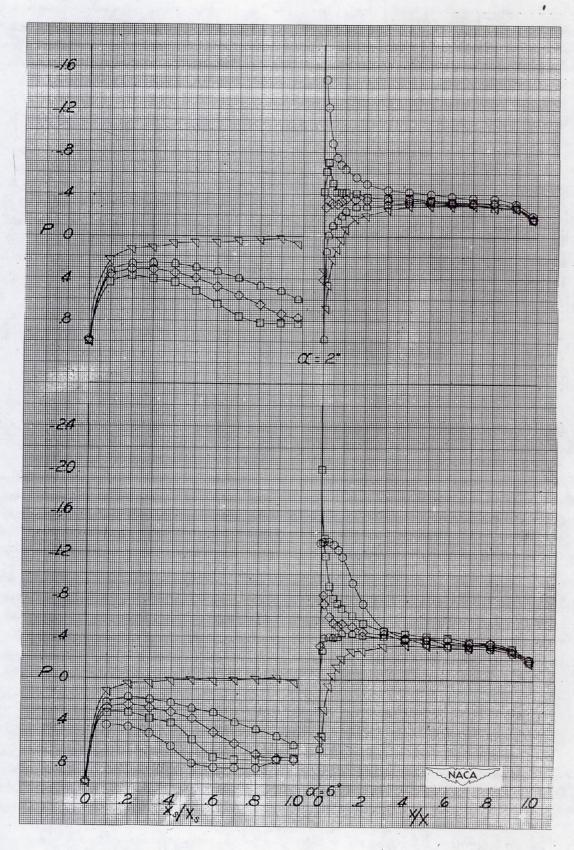


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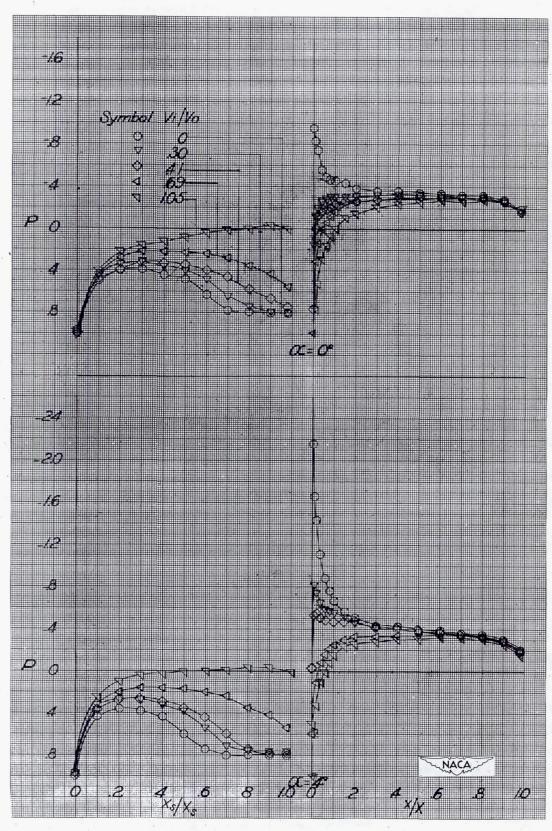


Figure 27.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-30-040 spinner.

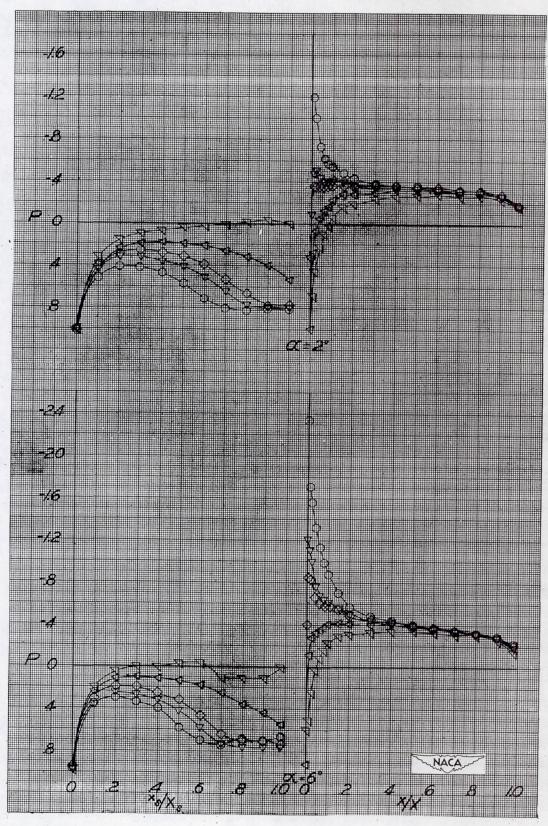


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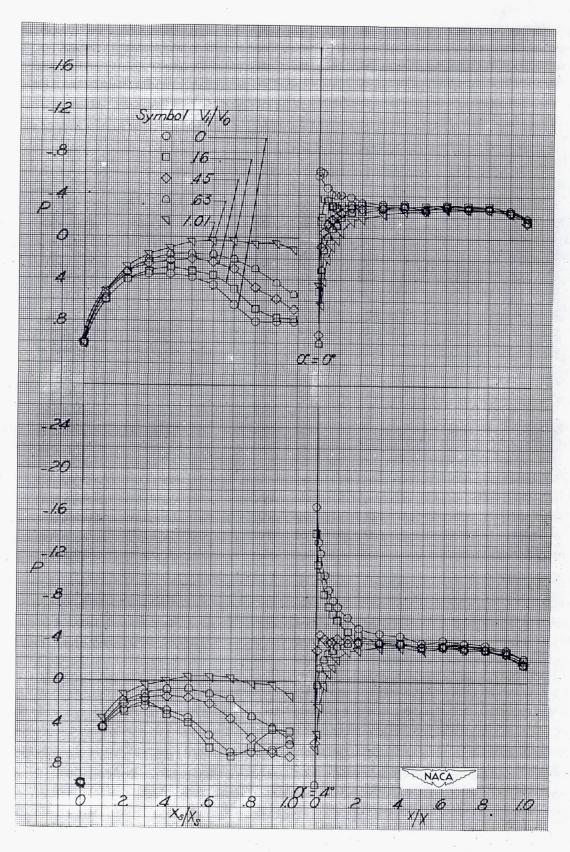


Figure 28.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-40-040 spinner.

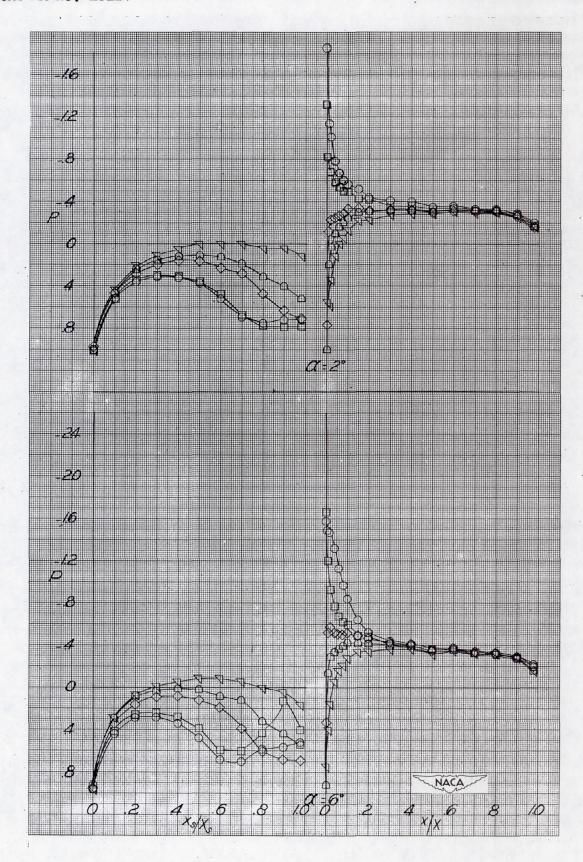


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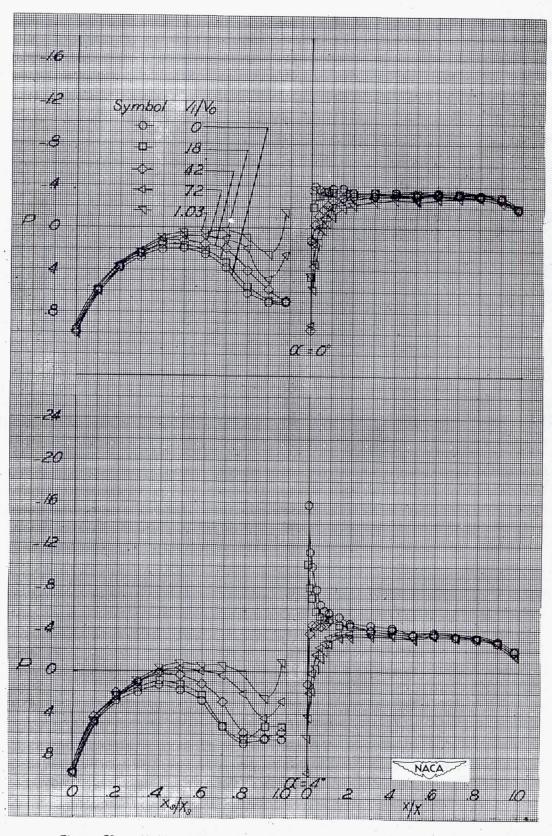


Figure 29.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-50-040 spinner.

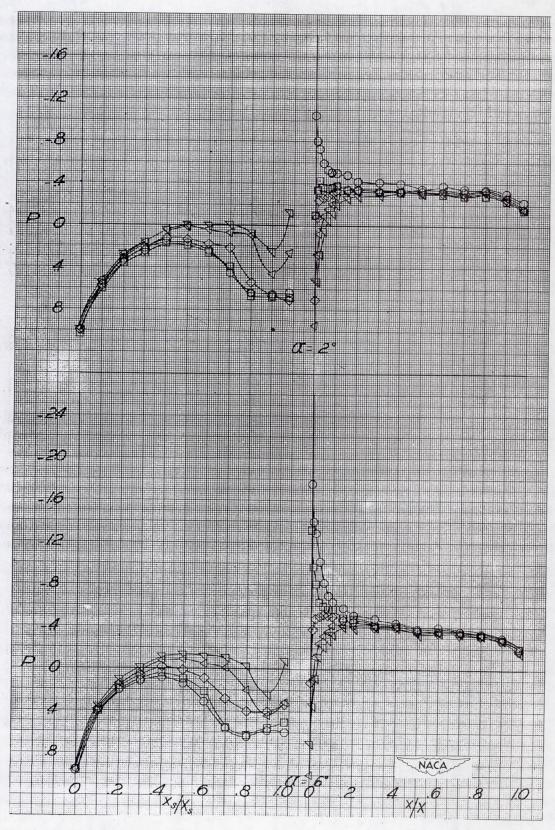


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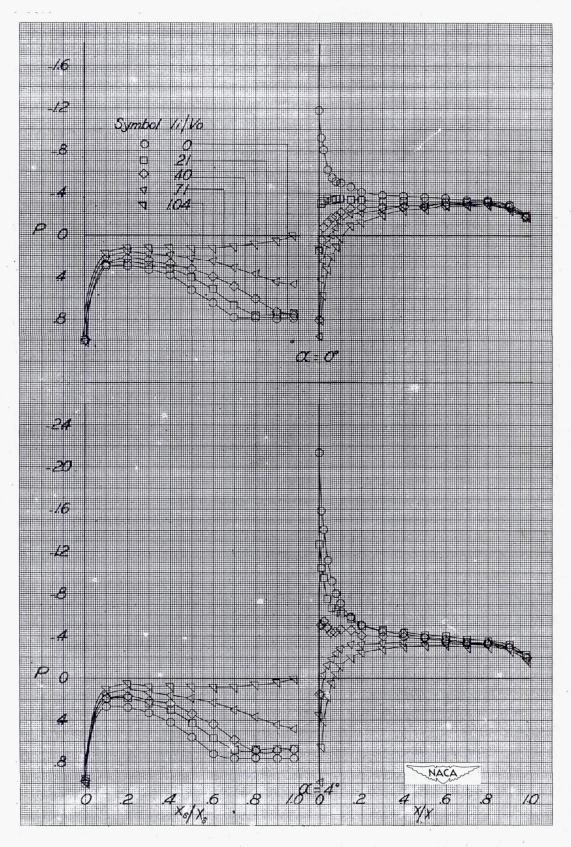


Figure 30.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-20-060 spinner.

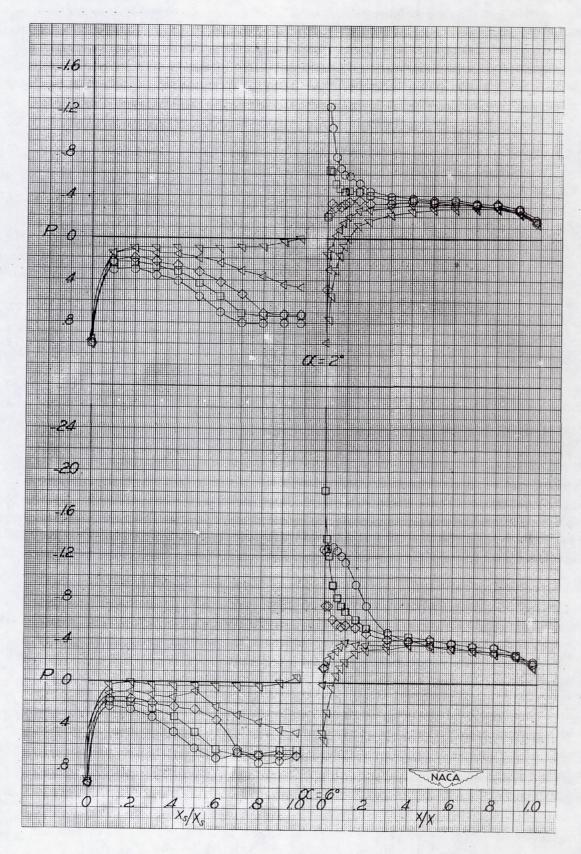


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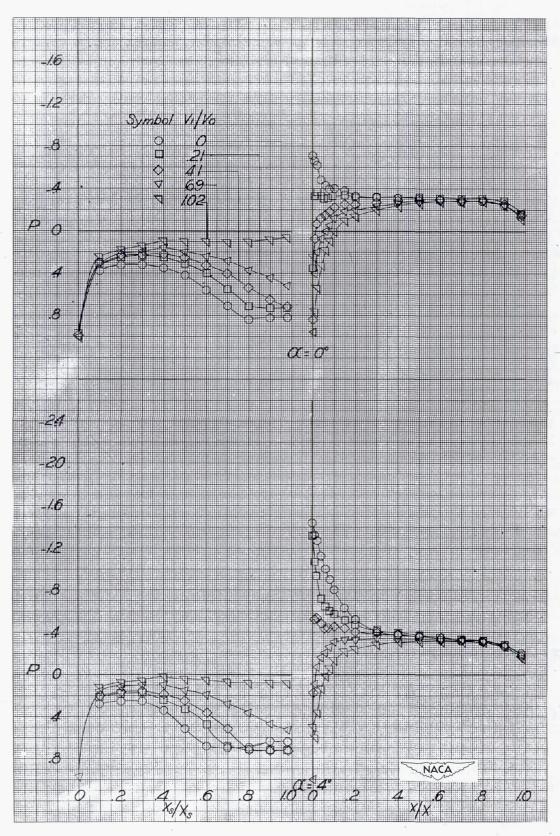


Figure 31.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-30-060 spinner.

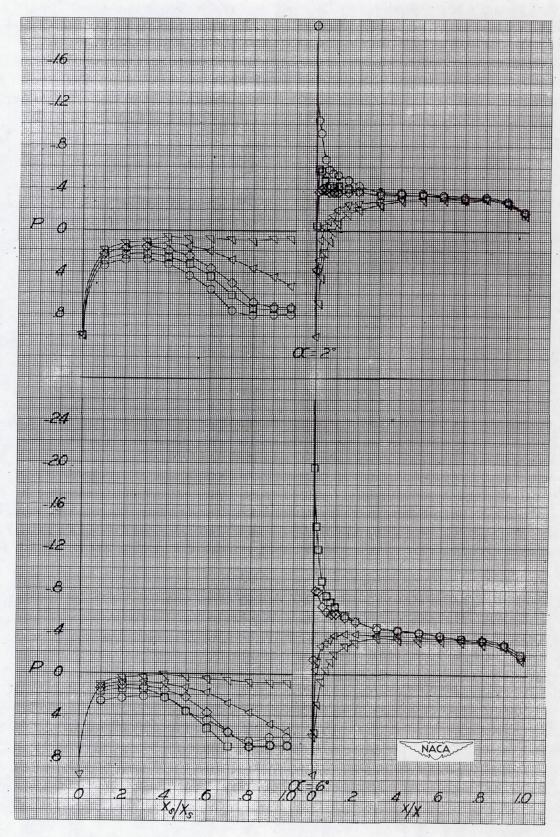


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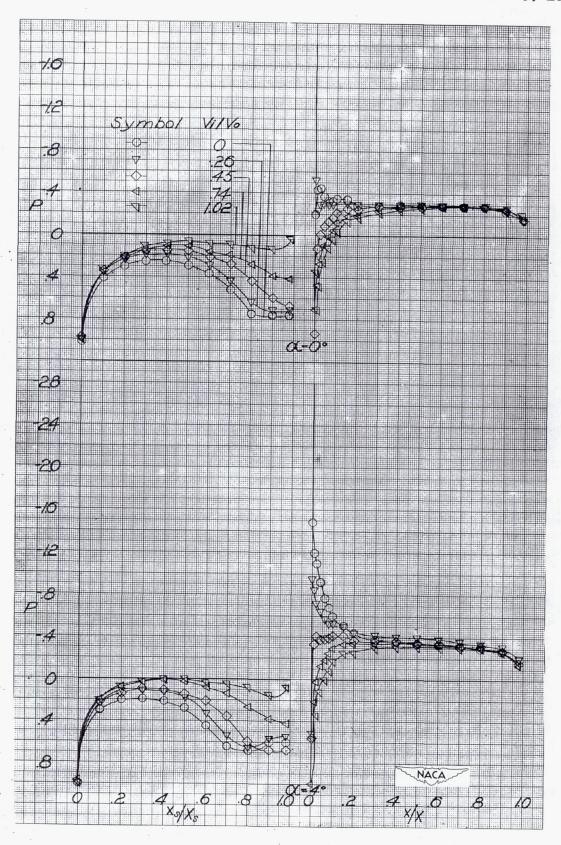


Figure 32.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-40-060 spinner.

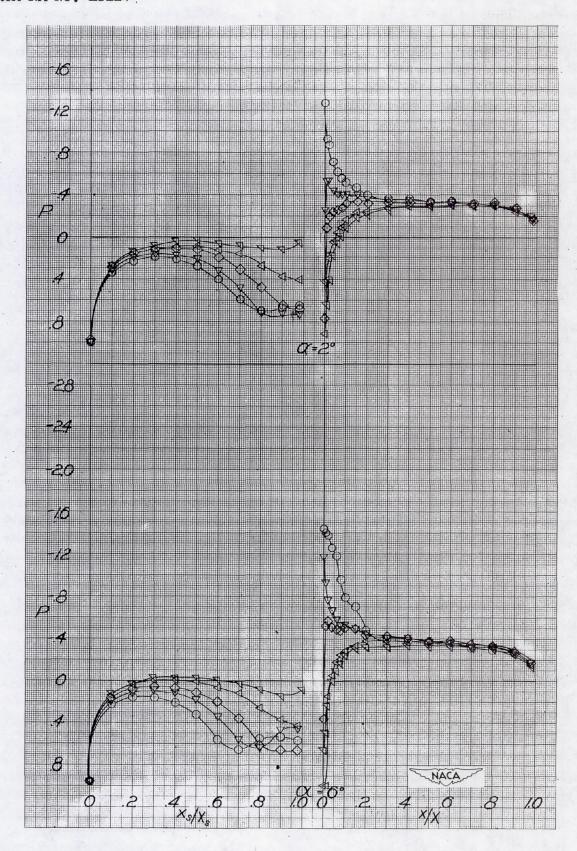


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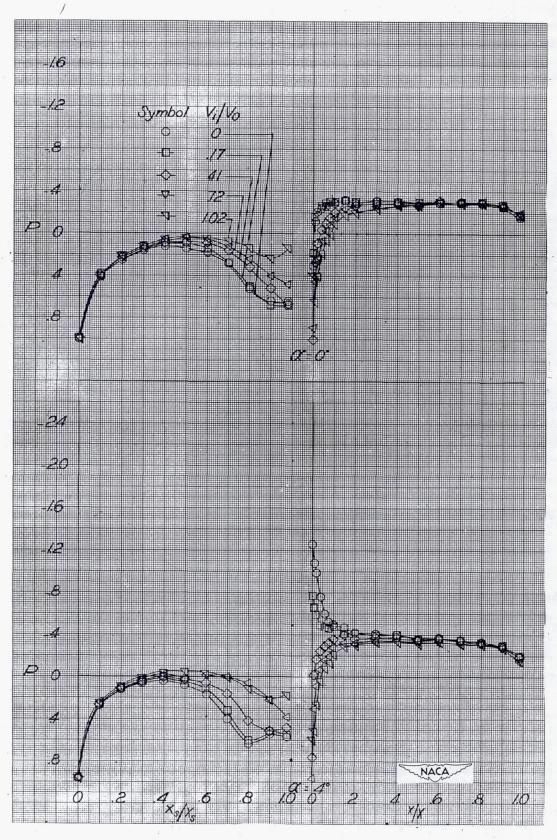


Figure 33.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-50-060 spinner.

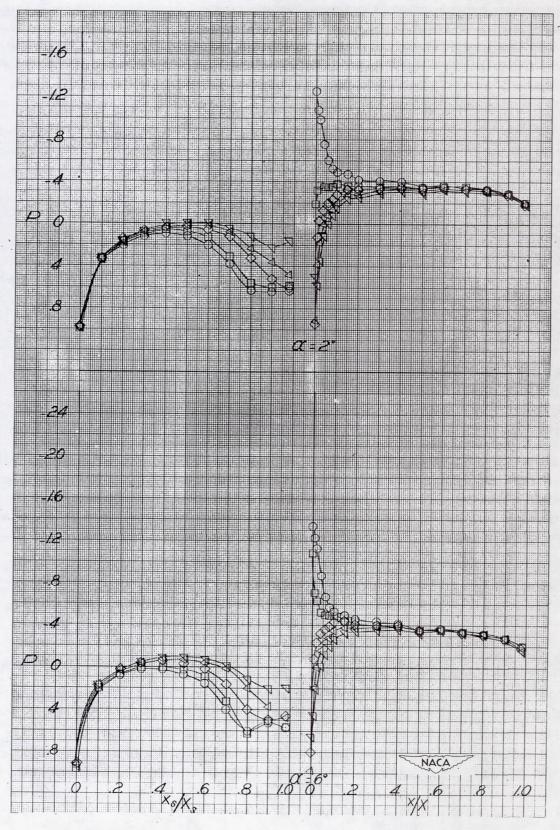


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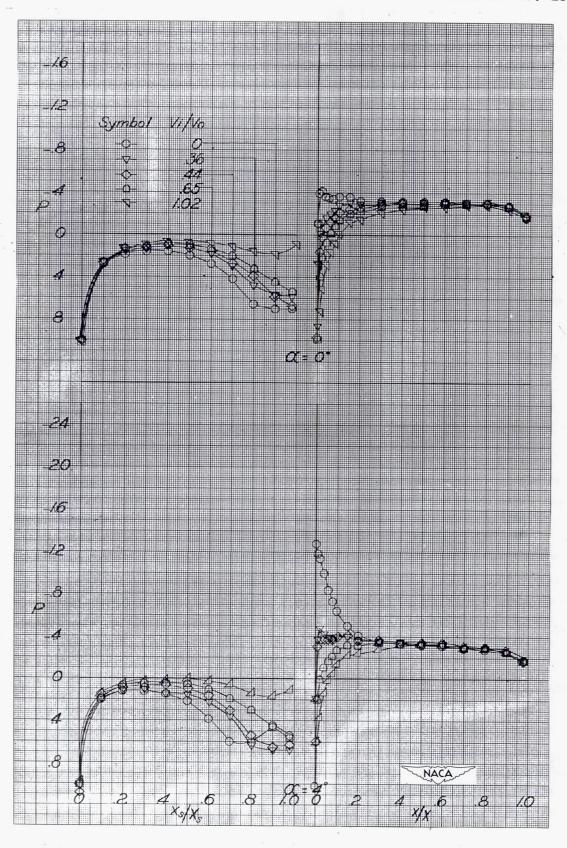


Figure 34.- Static-pressure distributions on top of NACA 1-60-075 cowling with NACA 1-40-080 spinner.

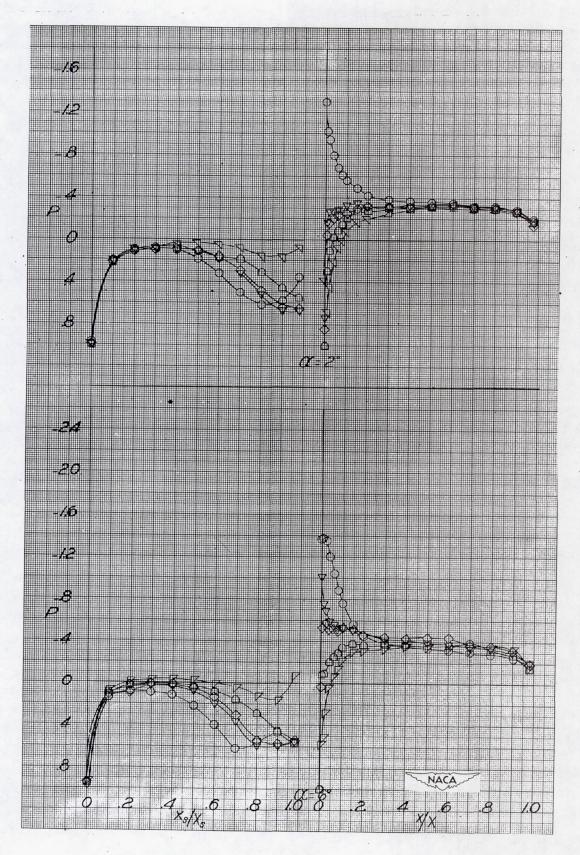


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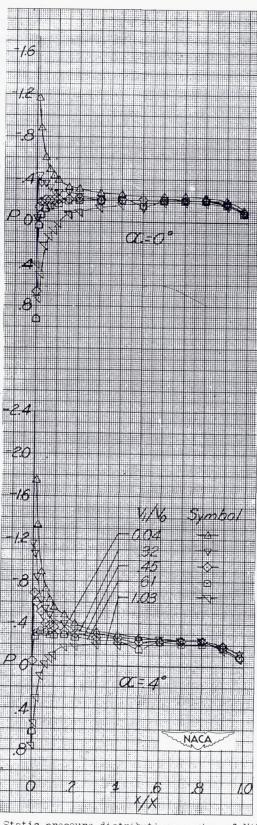


Figure 35.- Static-pressure distributions on top of NACA 1-60-100 open-nose cowling.

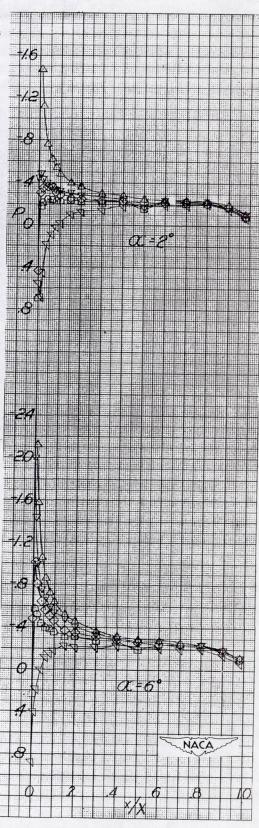


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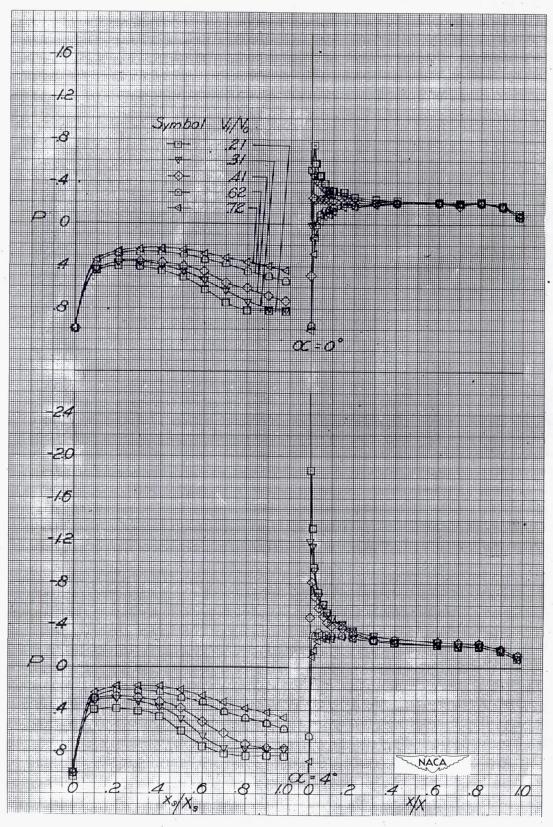


Figure 36.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-20-040 spinner.

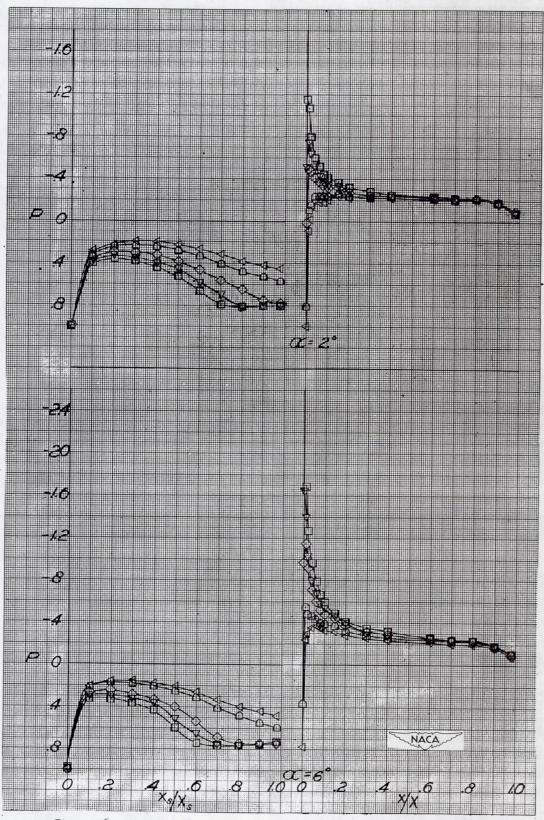


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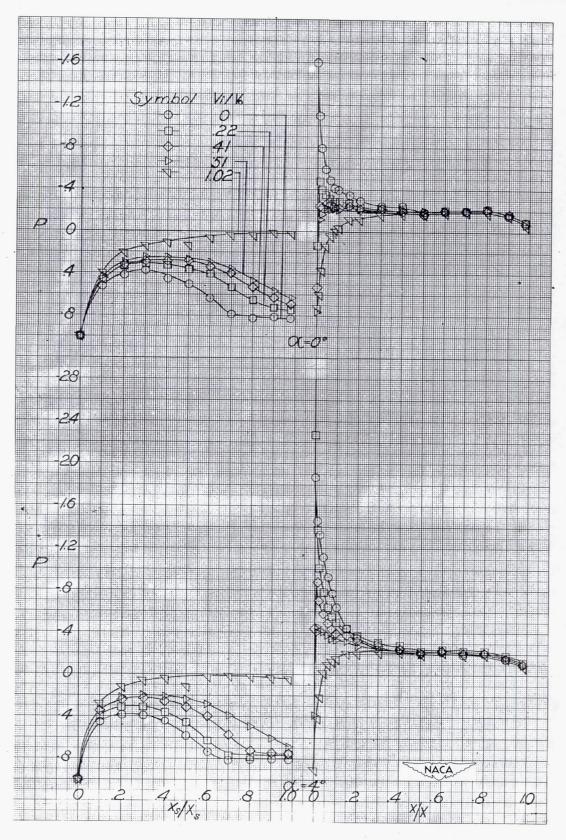


Figure 37.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-30-040 spinner.

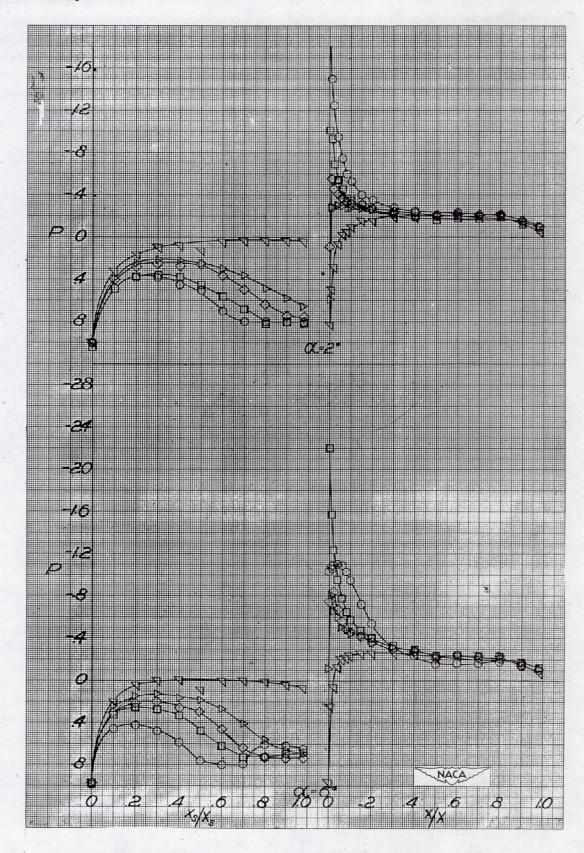


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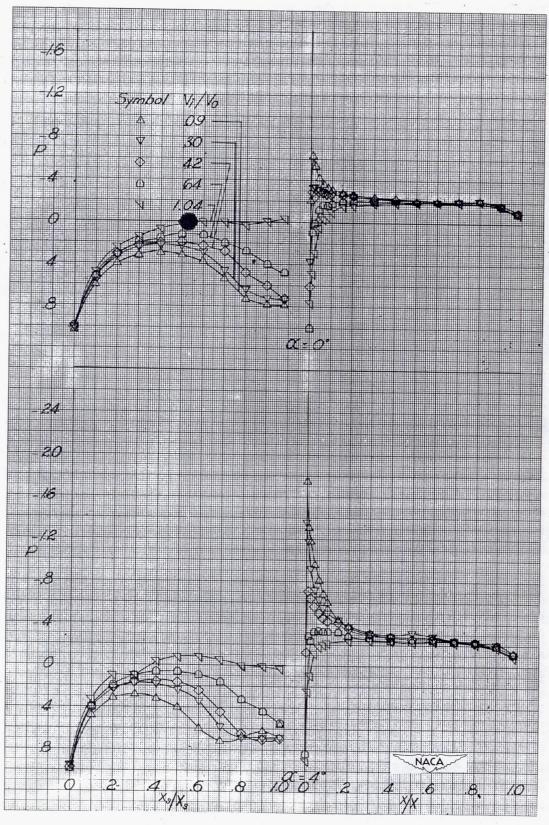


Figure 38.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-40-040 spinner.

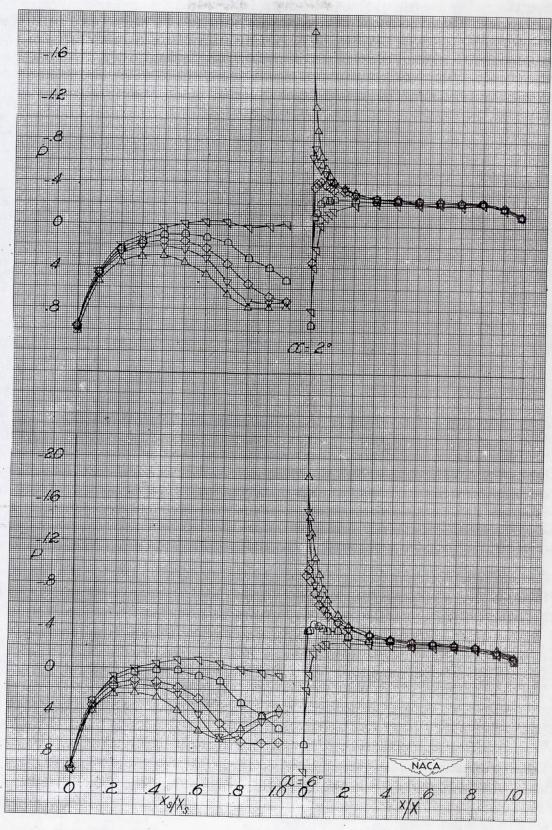


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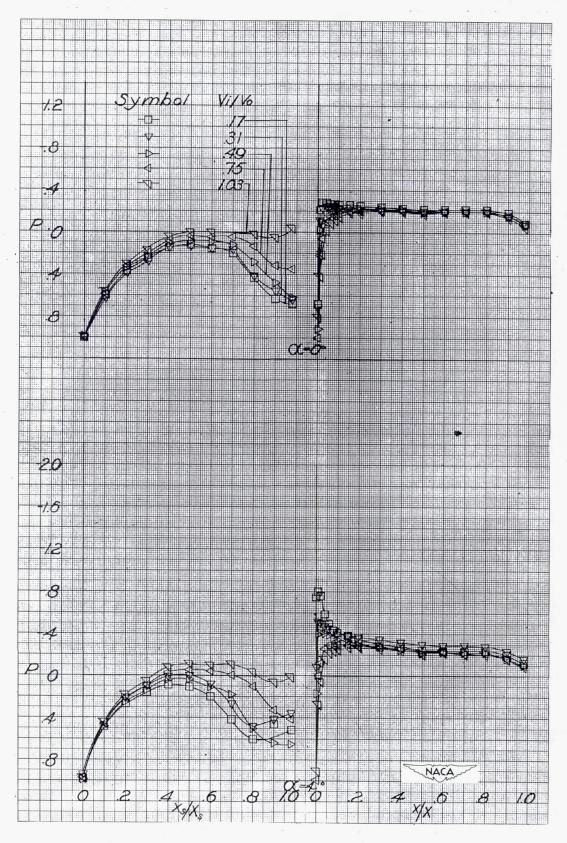


Figure 39.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-50-040 spinner.

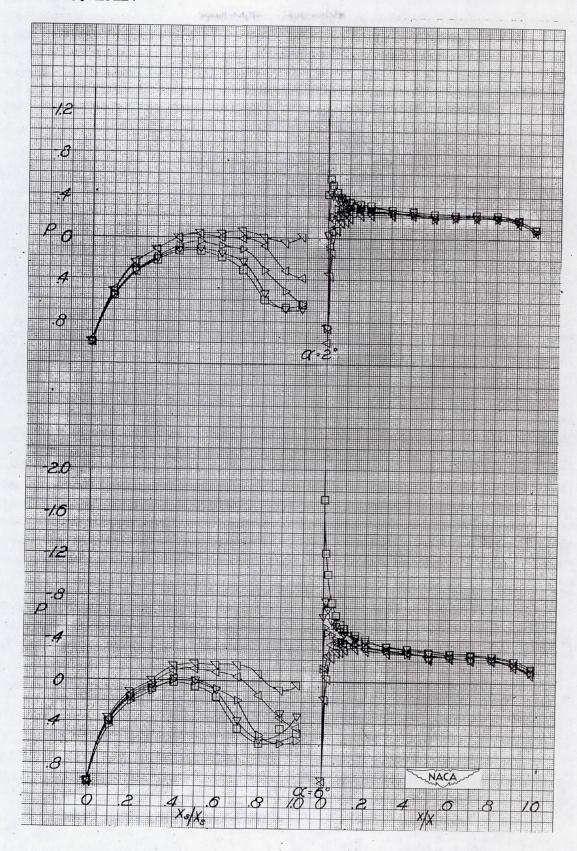


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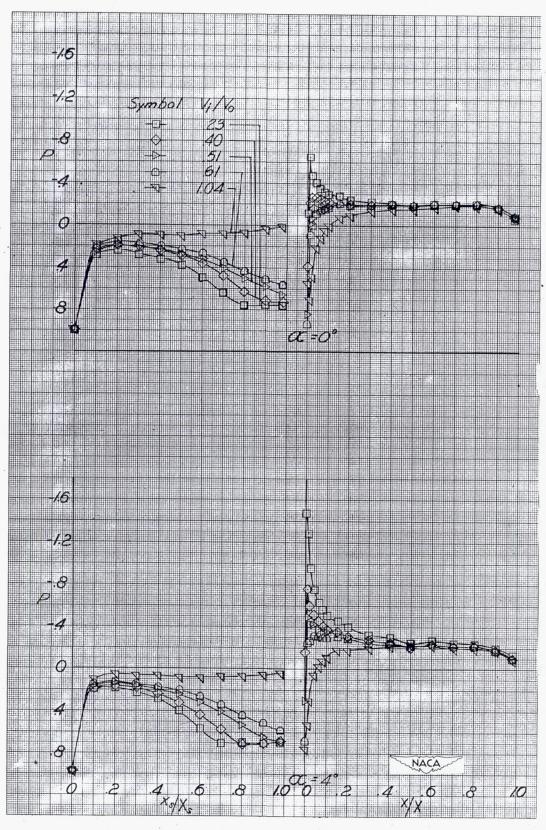


Figure 40.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-20-060 spinner.

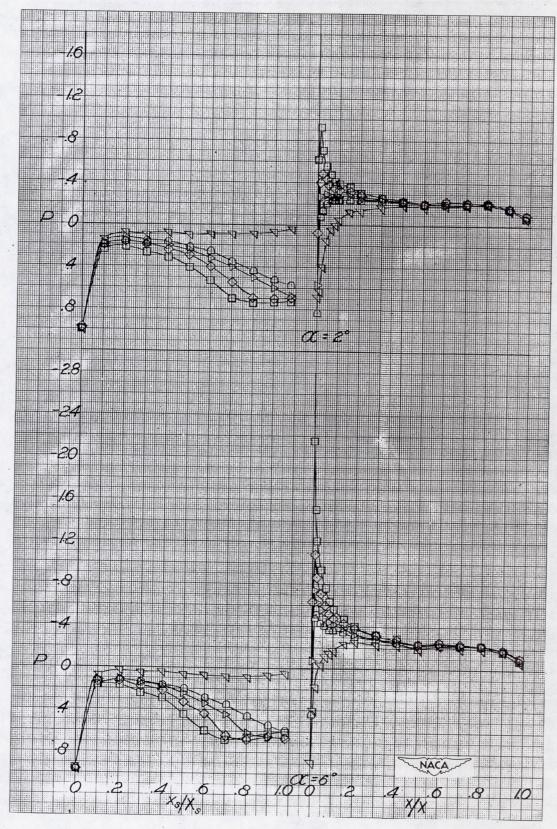


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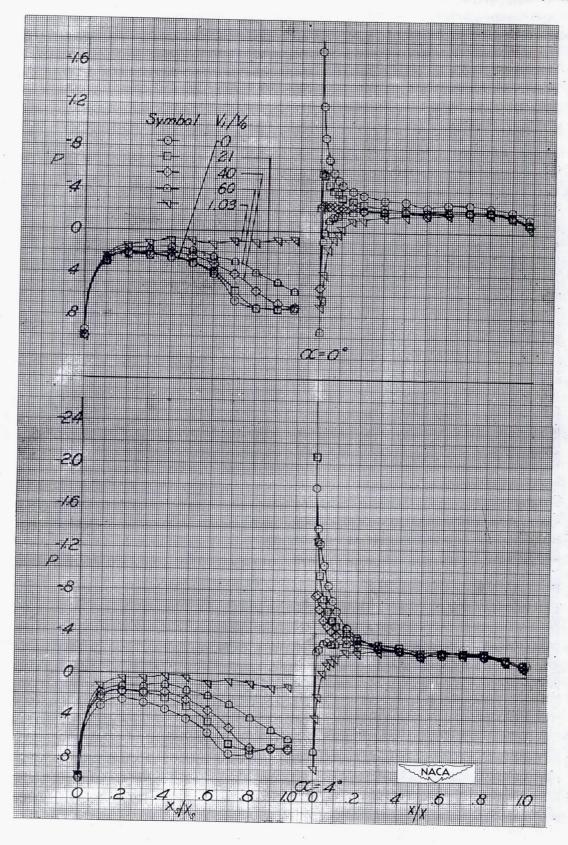


Figure 41.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-30-060 spinner.

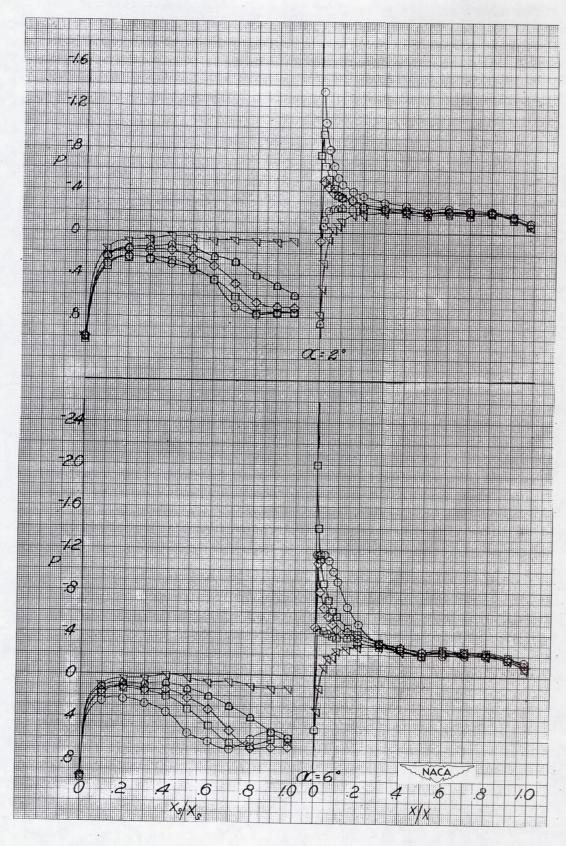


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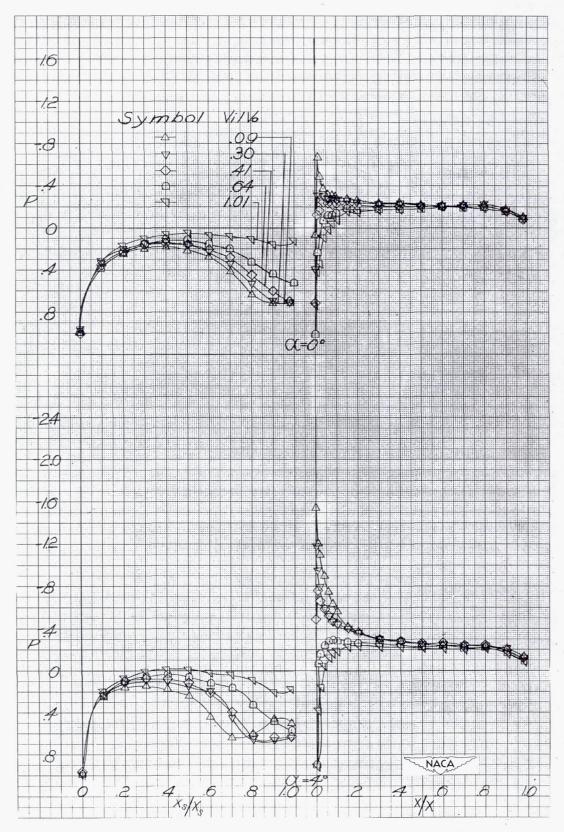


Figure 42.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-40-060 spinner.

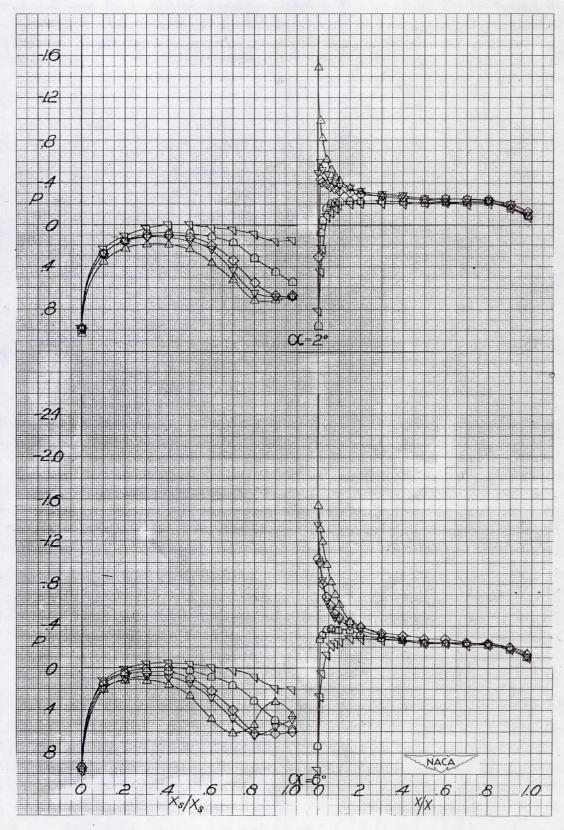


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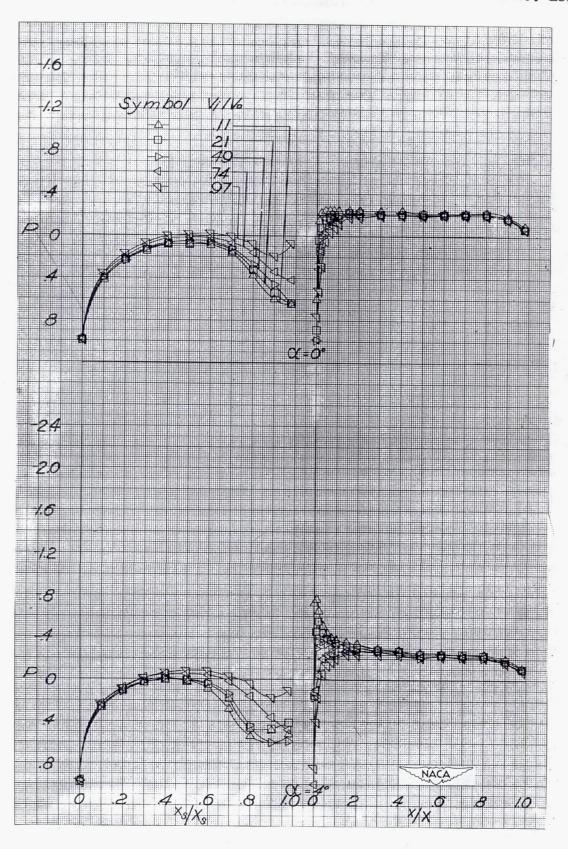


Figure 43.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-50-060 spinner.

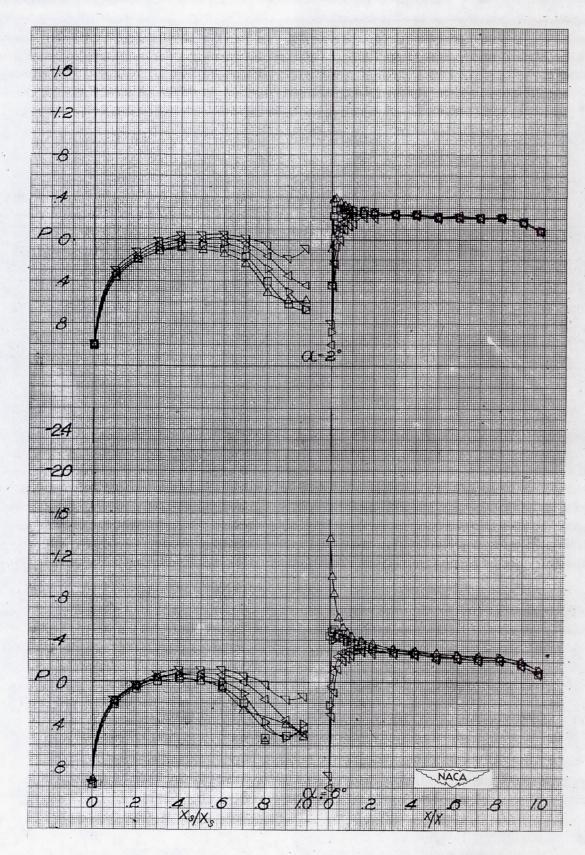


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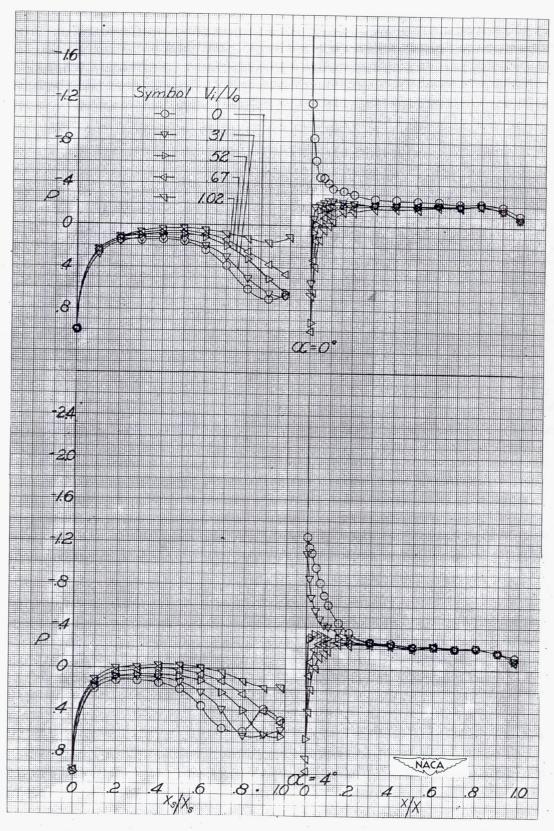


Figure 44.- Static-pressure distributions on top of NACA 1-60-100 cowling with NACA 1-40-080 spinner.

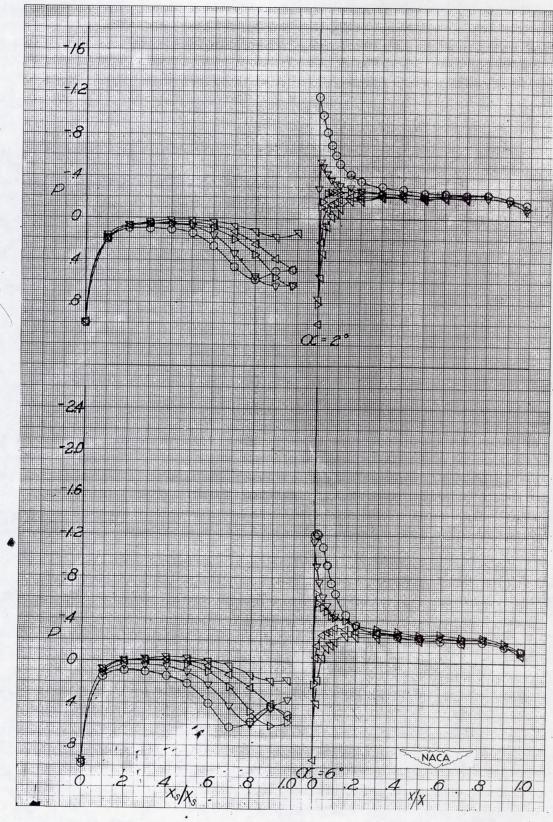


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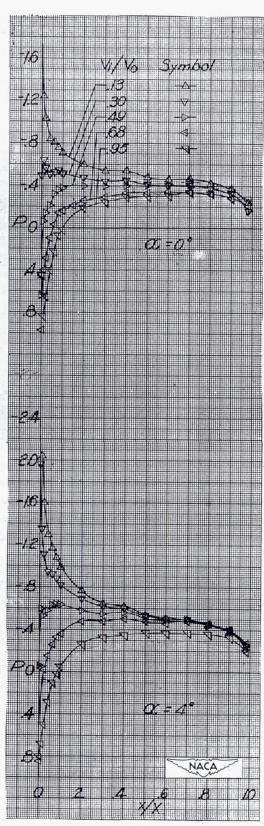


Figure 45.- Static-pressure distributions on top of NACA 1-70-050 open-nose cowling.

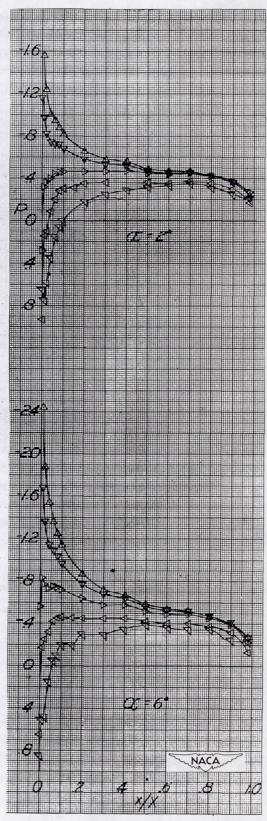


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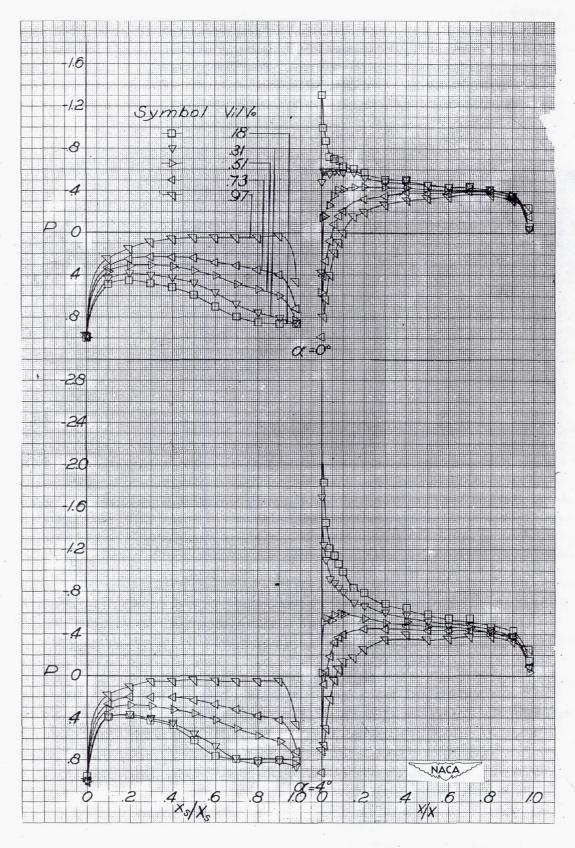


Figure 46.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-20-040 spinner.

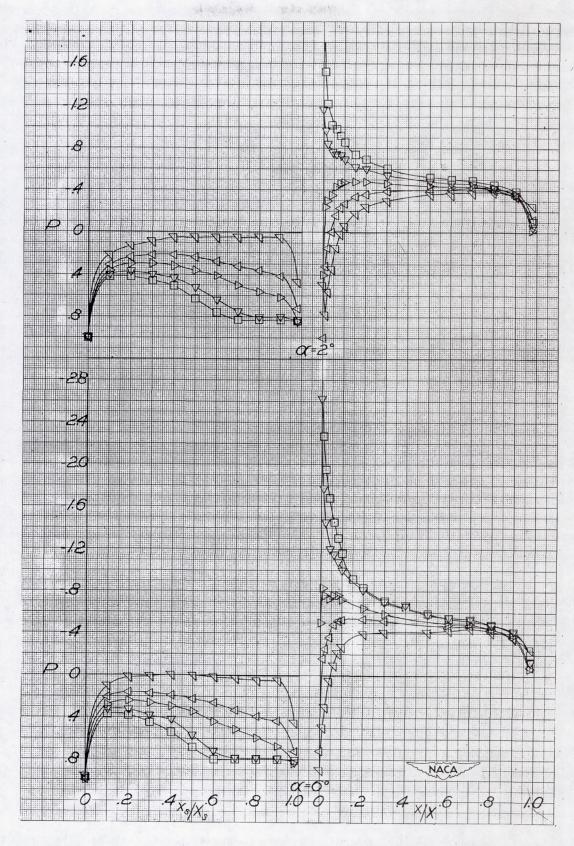


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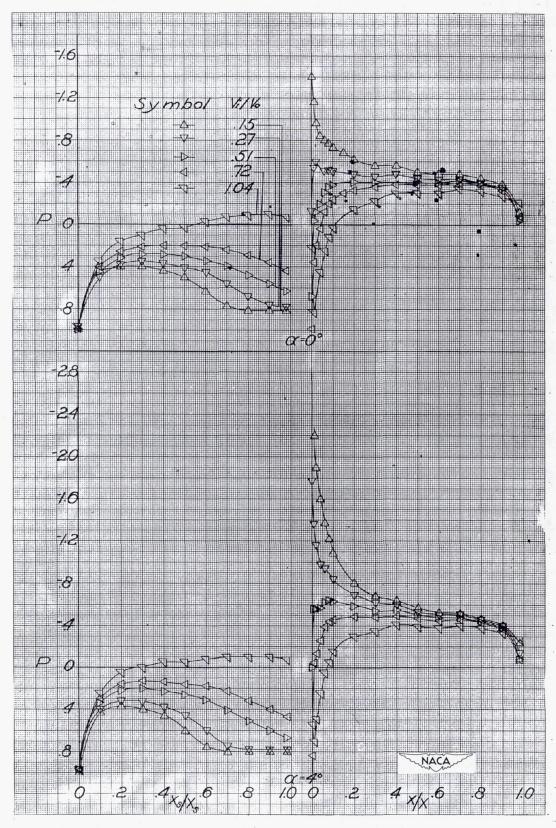


Figure 47.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-30-040 spinner.

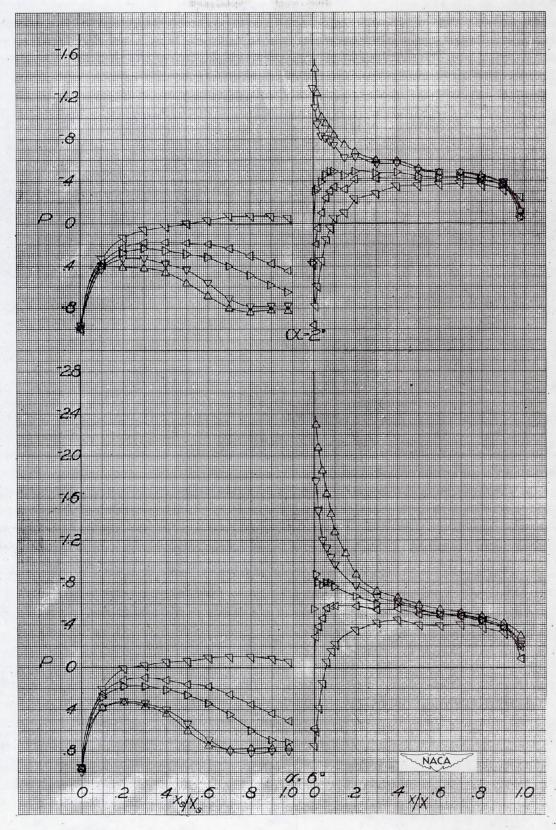


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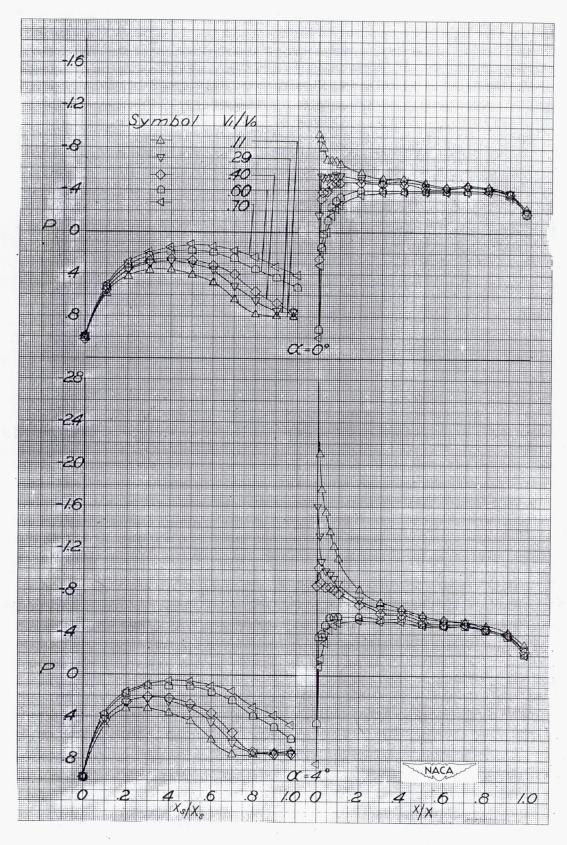


Figure 48.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-40-040 spinner.

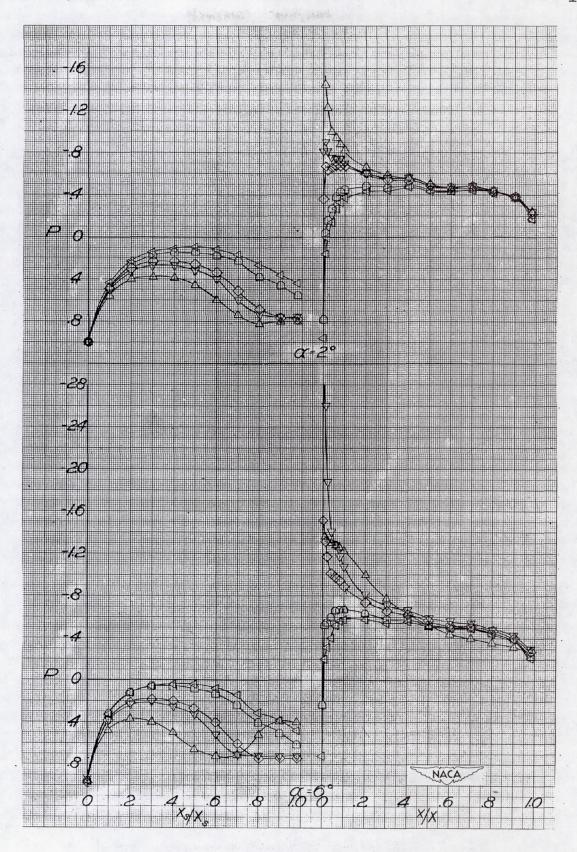


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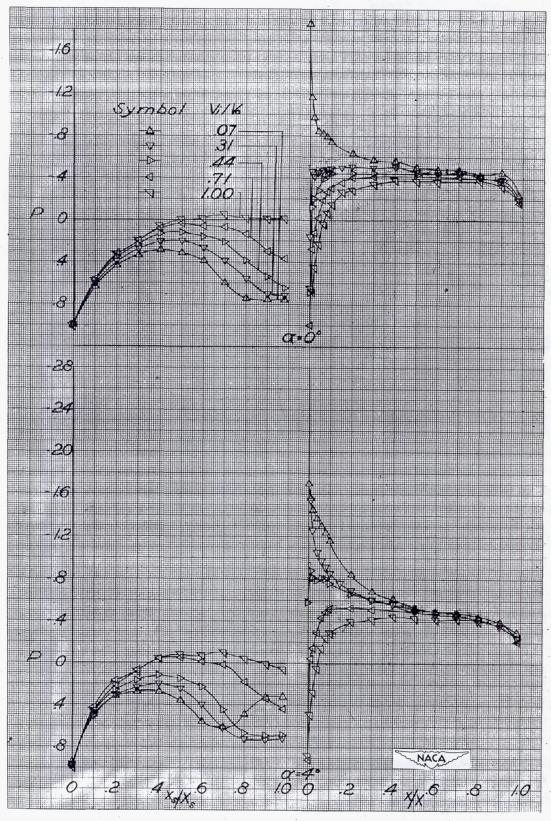


Figure 49.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-50-040 spinner.

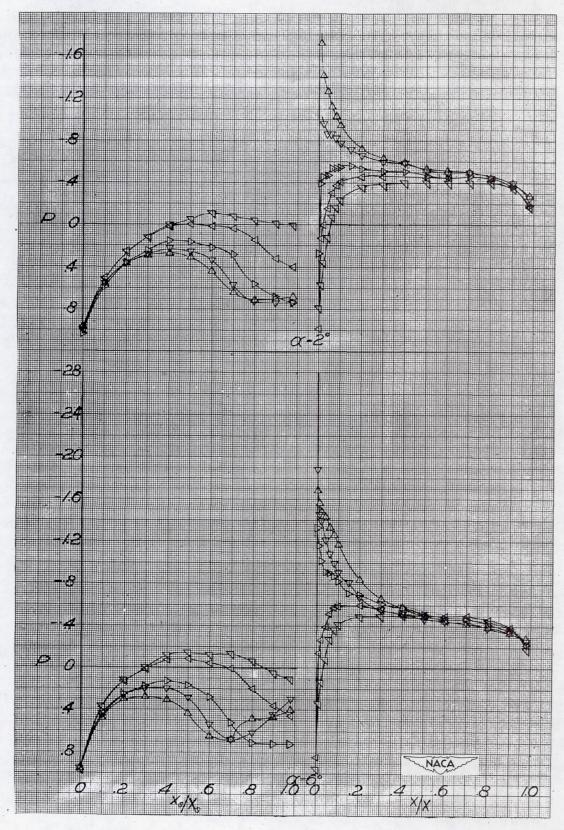


Figure 49.- Concluded.

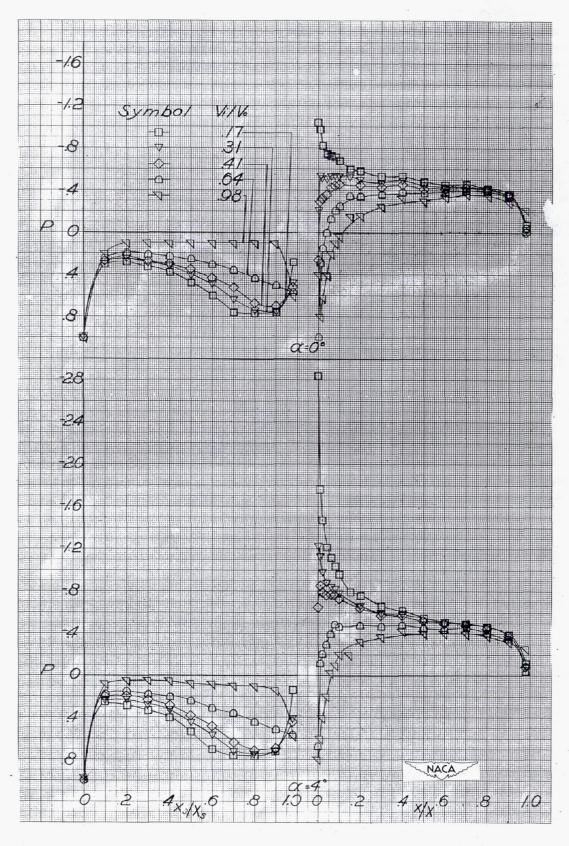


Figure 50.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-20-060 spinner.

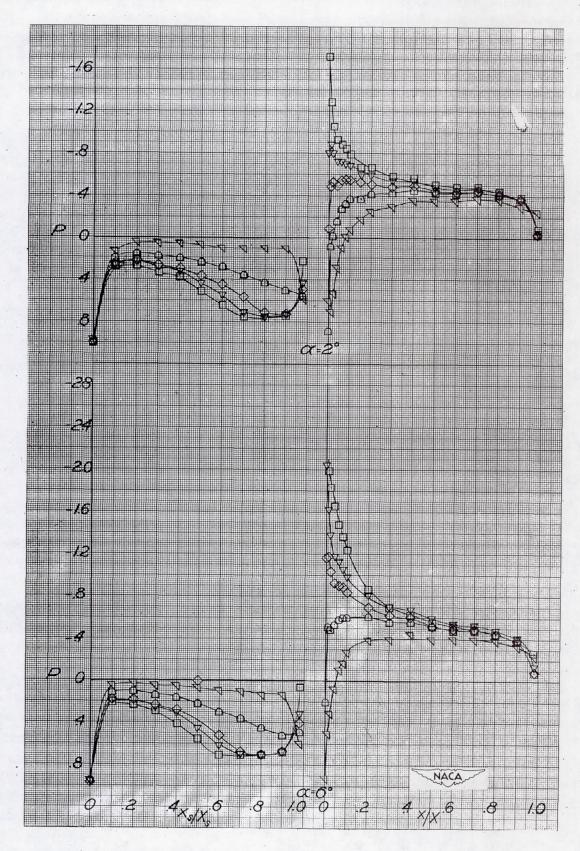


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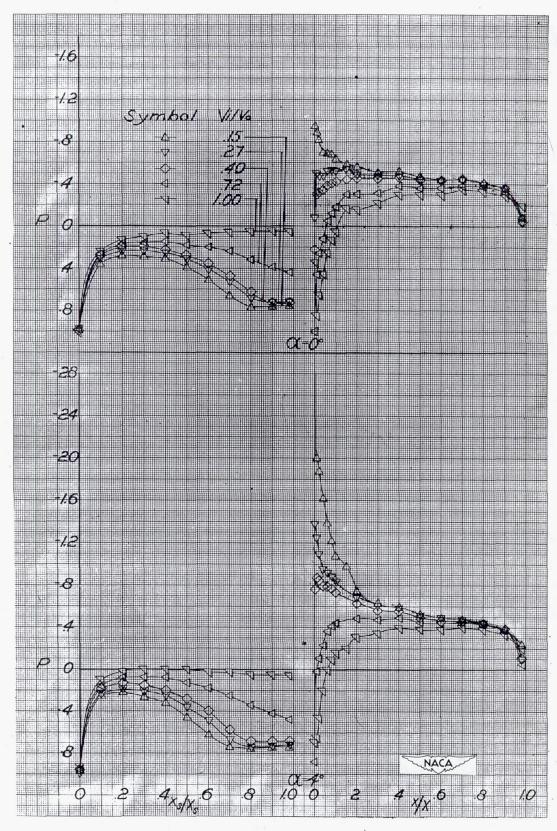
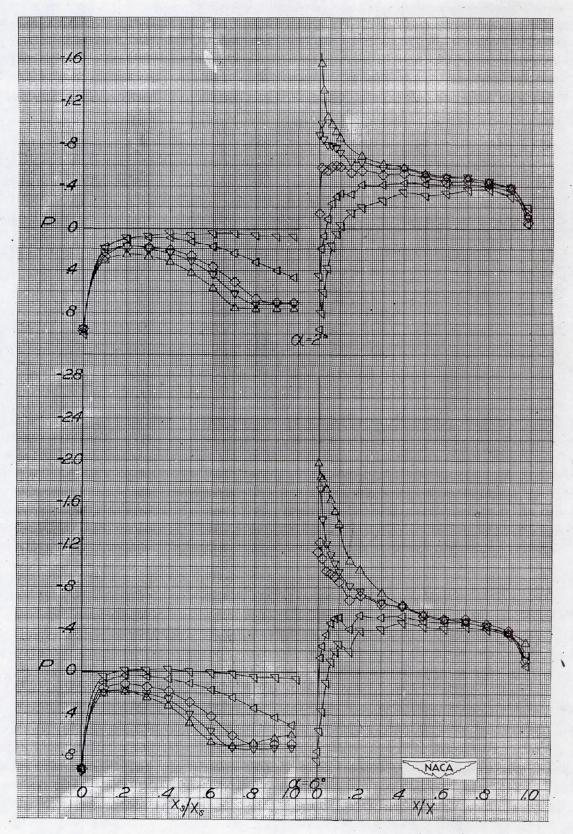


Figure 51.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-30-060 spinner.



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Figure 51.- Concluded.

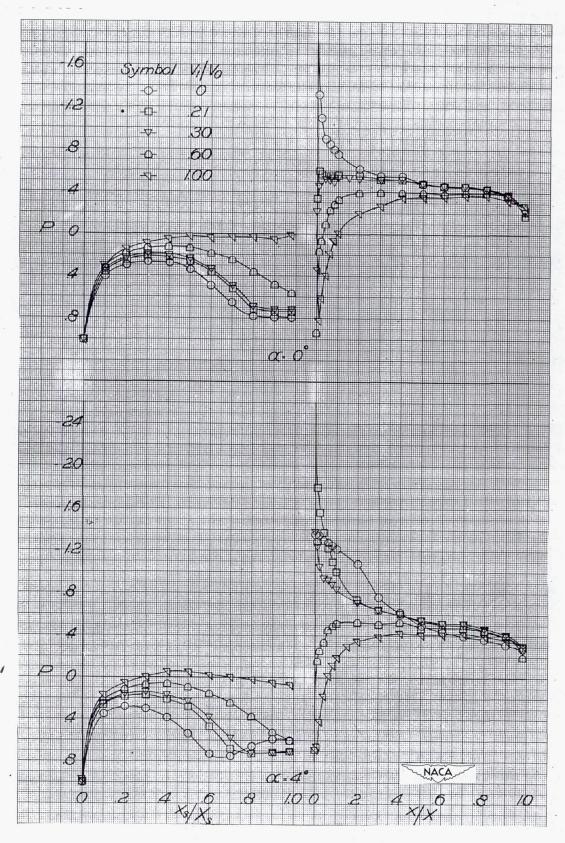


Figure 52.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-40-060 spinner.

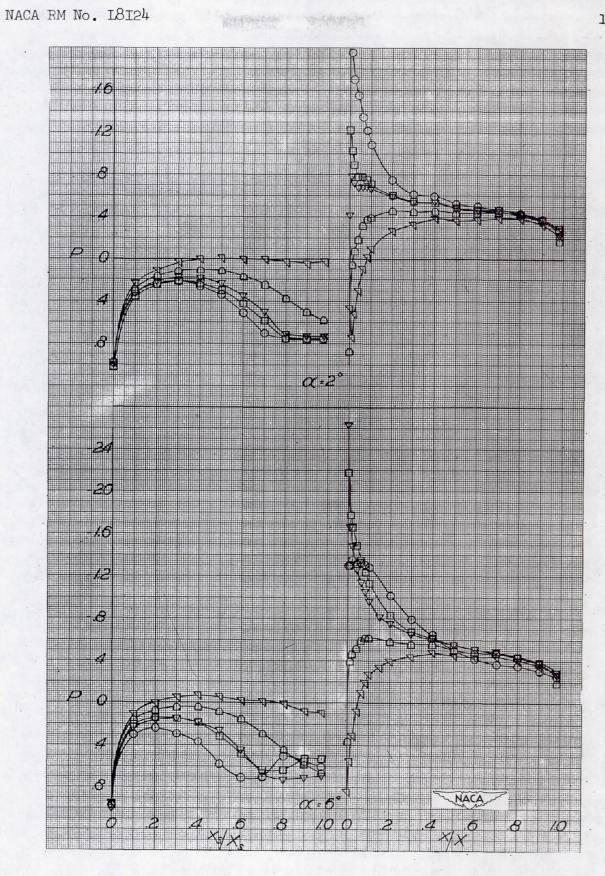


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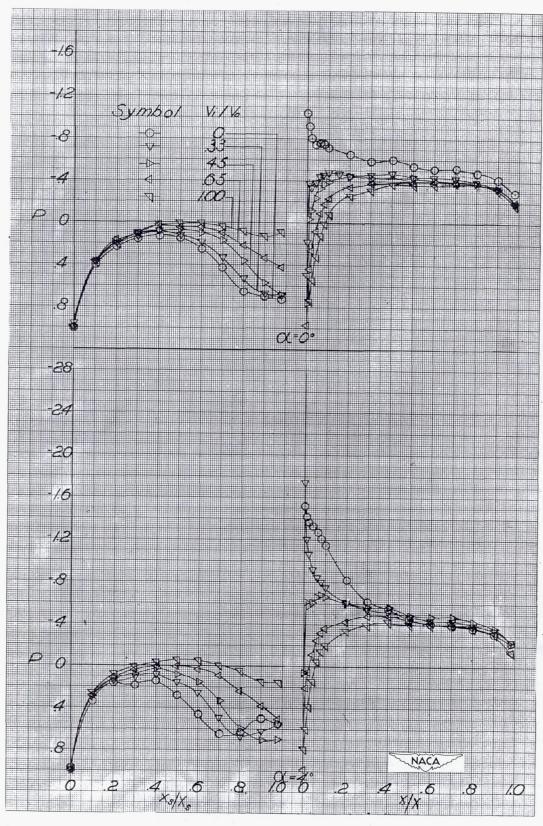
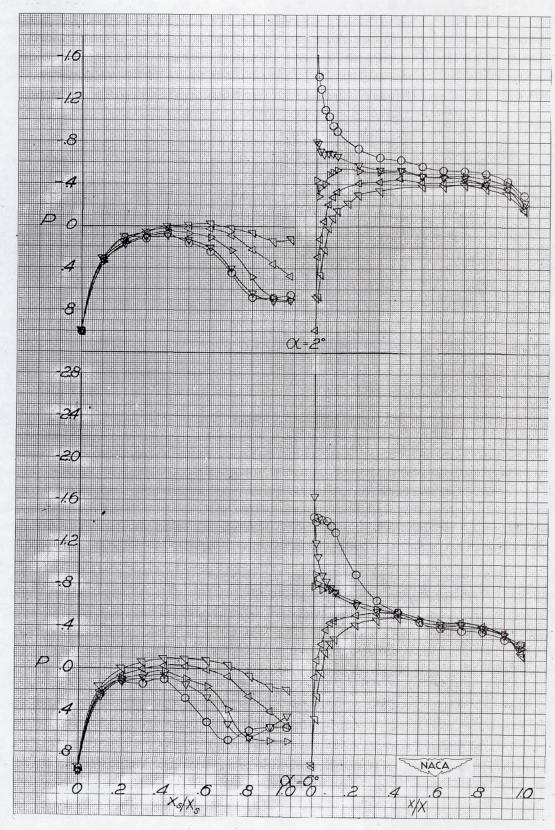


Figure 53.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-50-060 spinner.



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Figure 53.- Concluded.

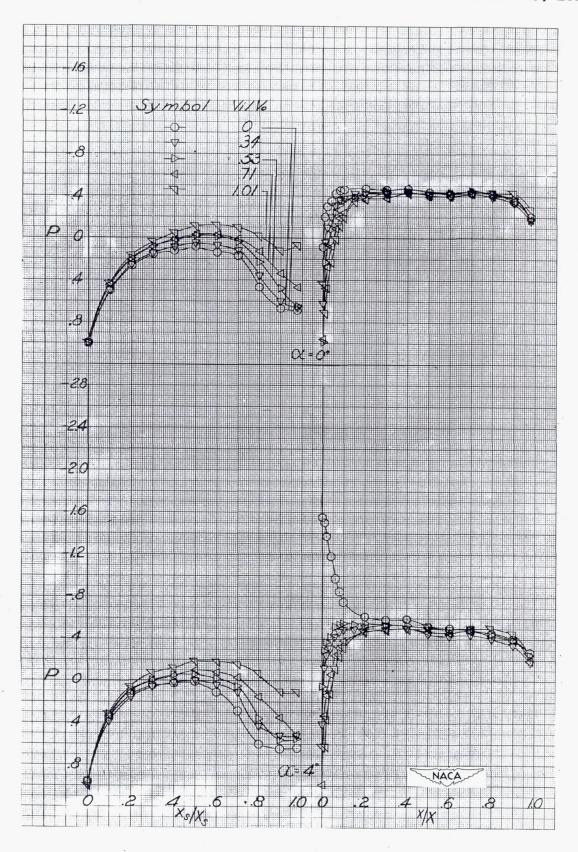


Figure 54.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-60-060 spinner.

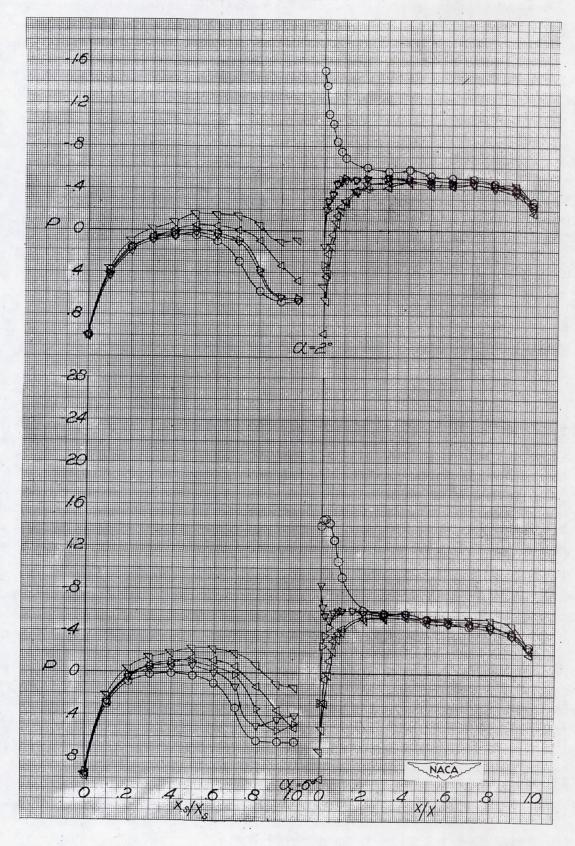


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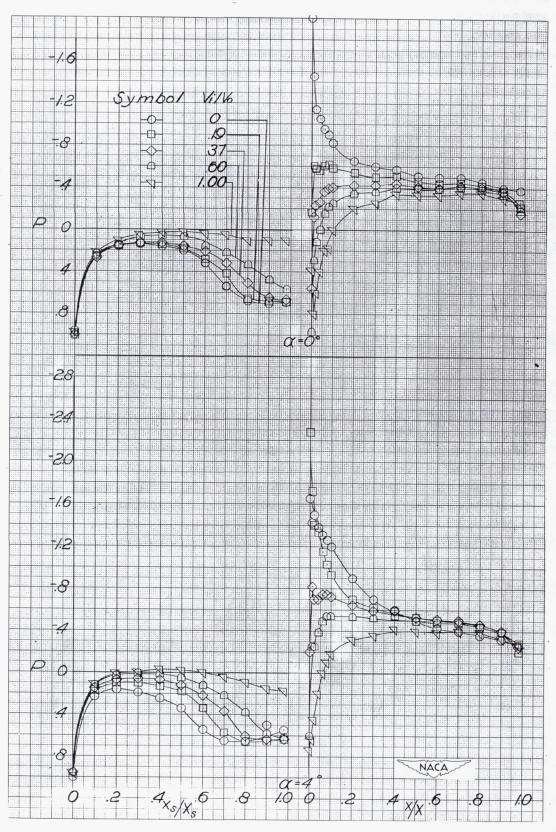


Figure 55.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-40-080 spinner.

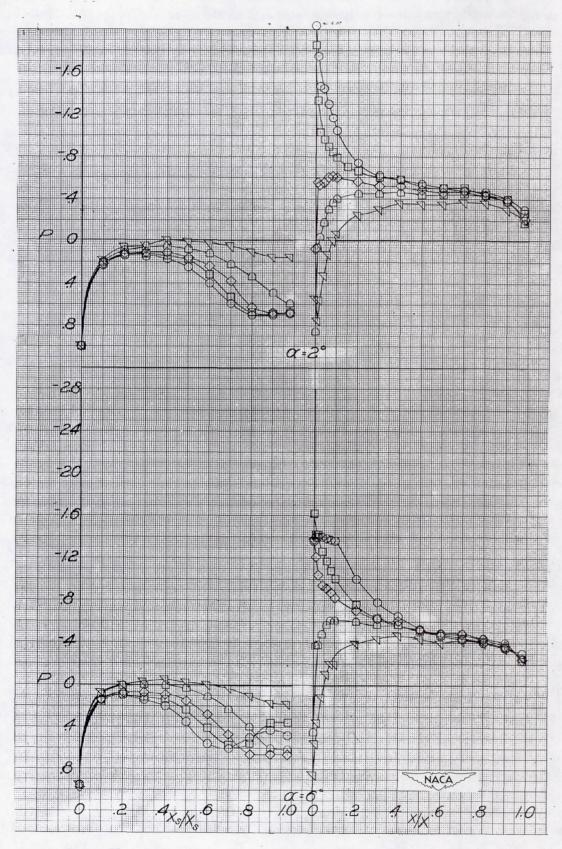


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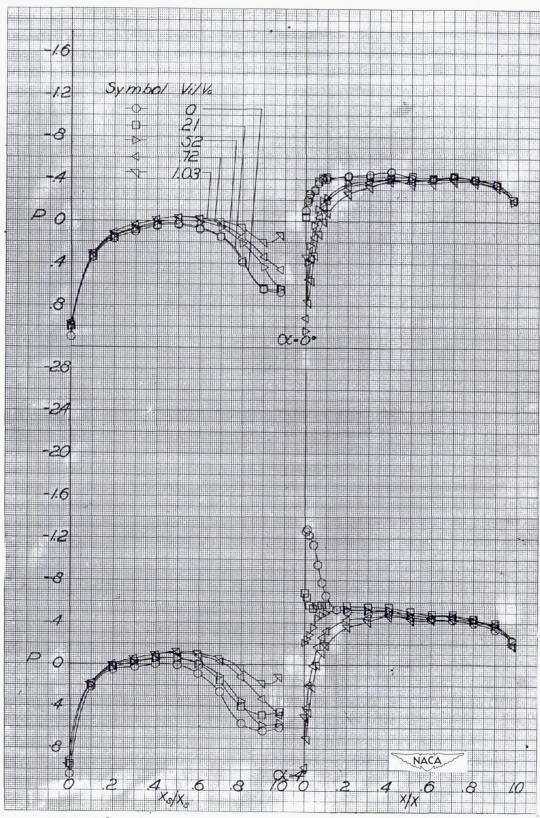
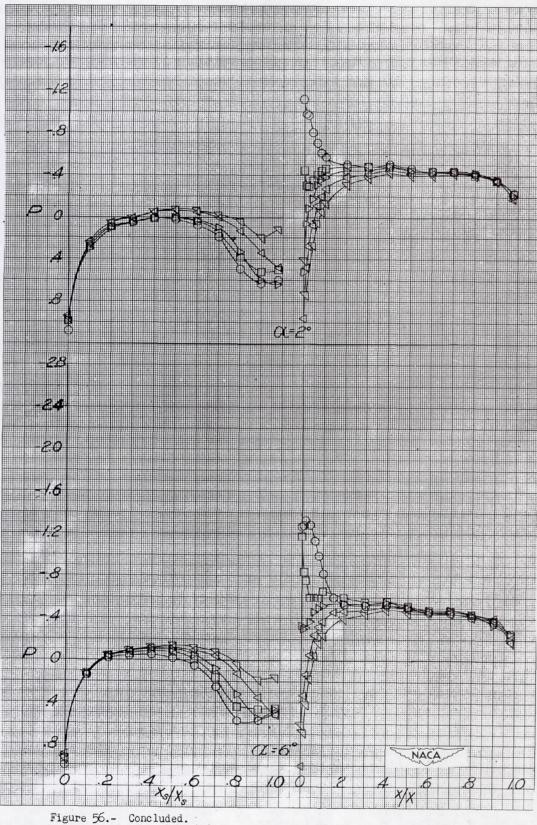


Figure 56.- Static-pressure distributions on top of NACA 1-70-050 cowling with NACA 1-60-080 spinner.



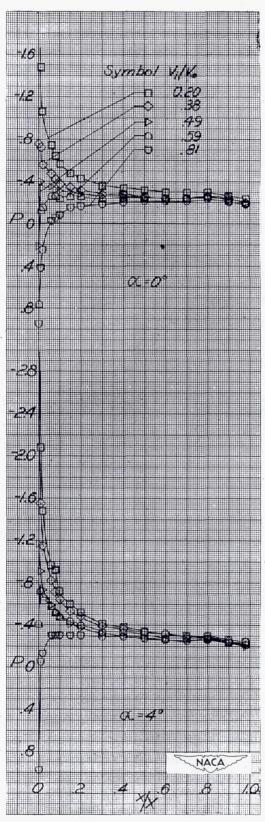


Figure 57.- Static-pressure distributions on top of NACA 1-70-075 open-nose cowling.

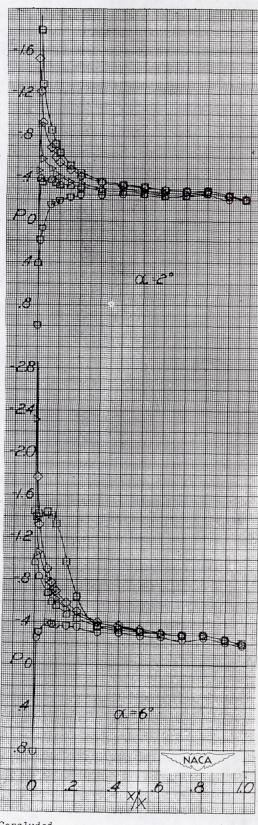


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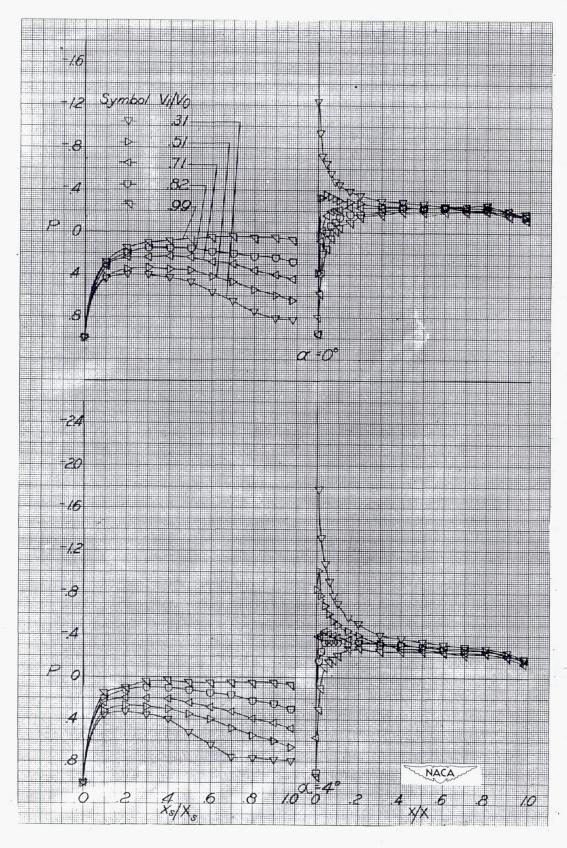


Figure 58.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-20-040 spinner.

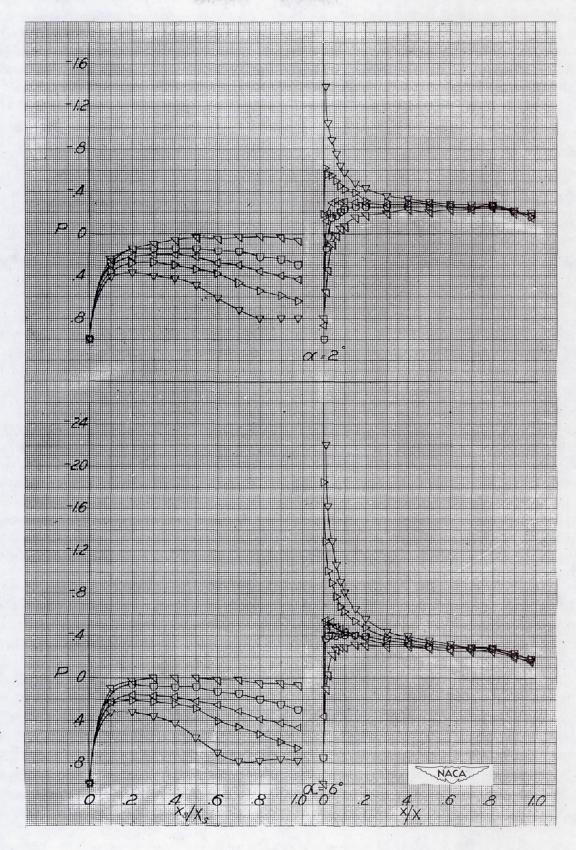


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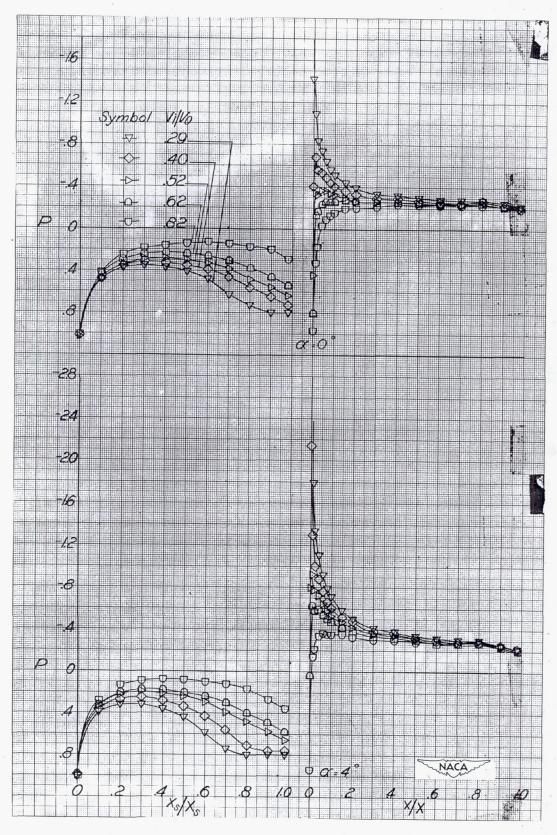


Figure 59.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-30-040 spinner.

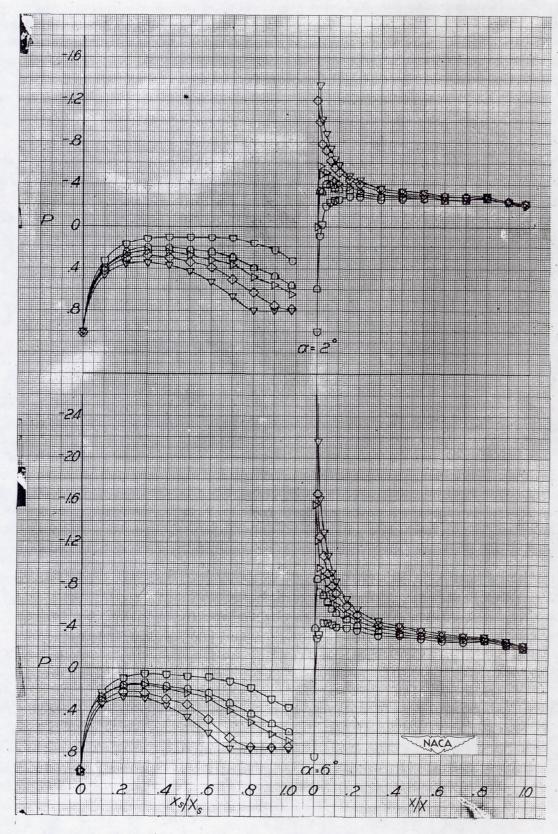


Figure 59.- Concluded.

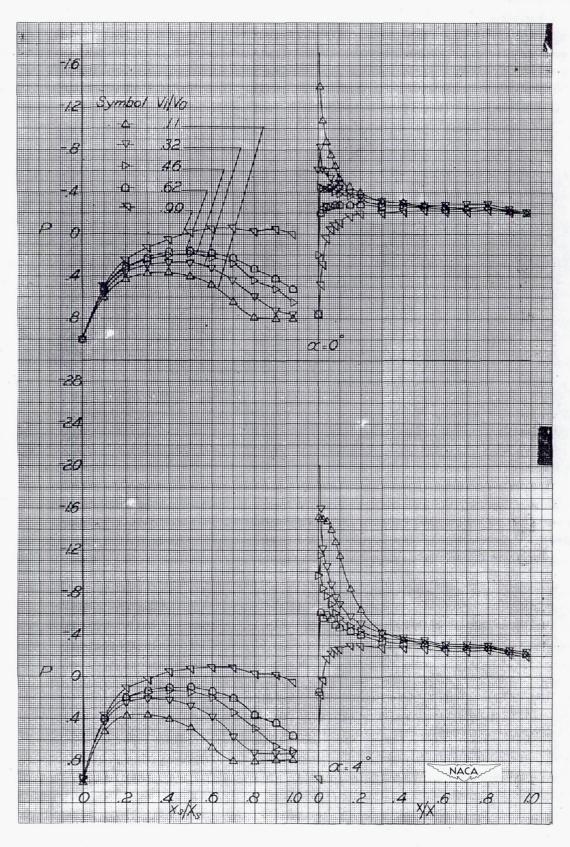


Figure 60.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-40-040 spinner.

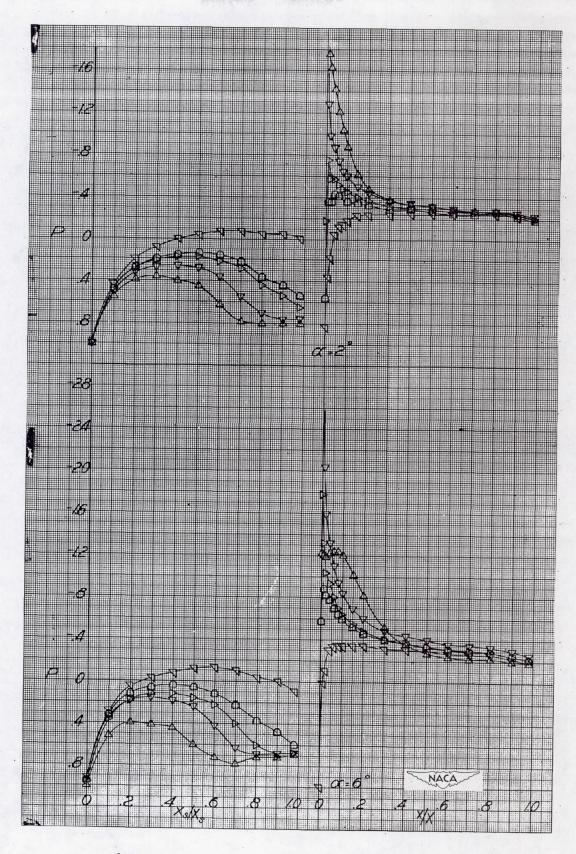


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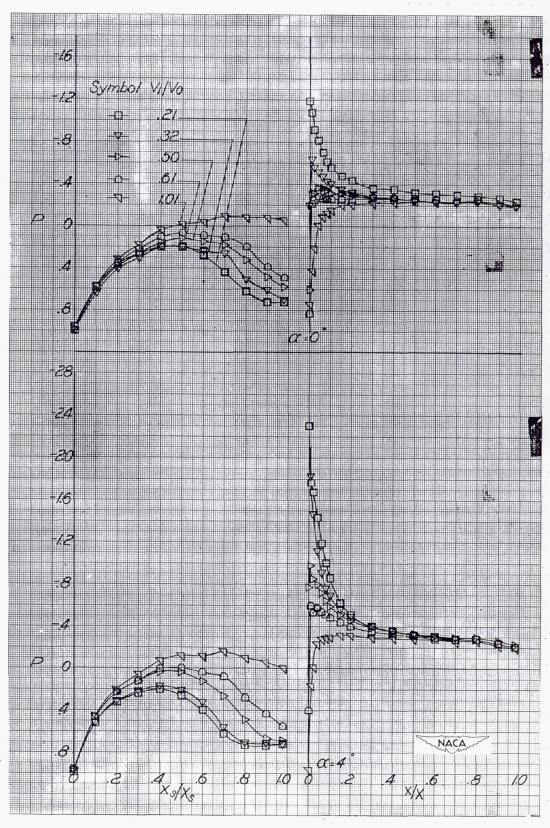
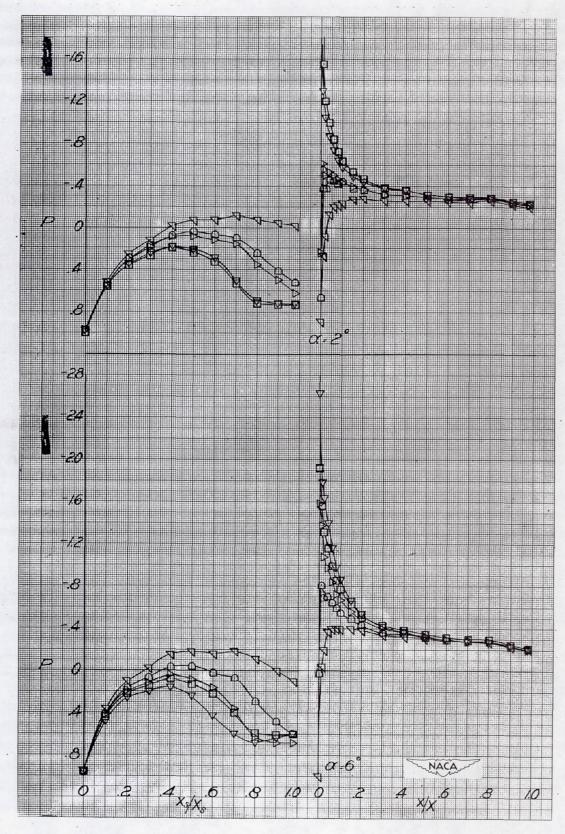


Figure 61.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-50-040 spinner.



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Figure 61.- Concluded.

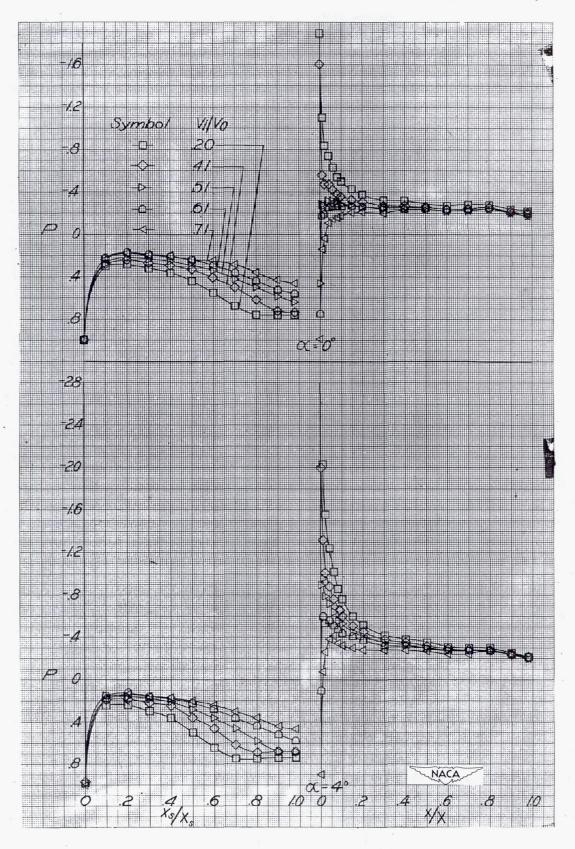


Figure 62.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-20-060 spinner.

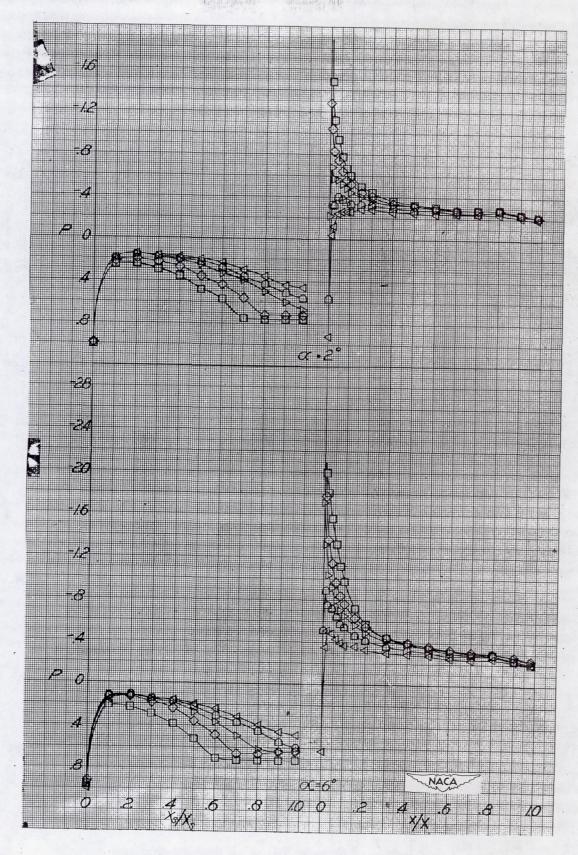


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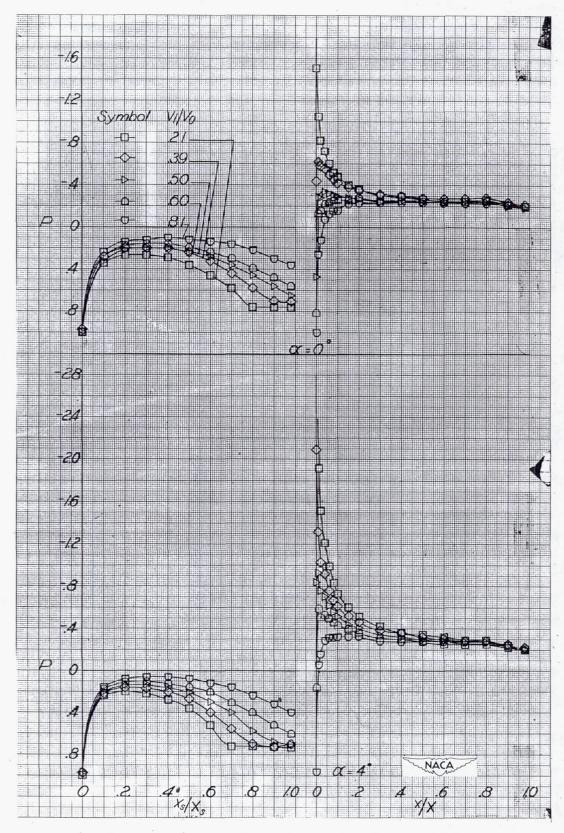


Figure 63.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-30-060 spinner.

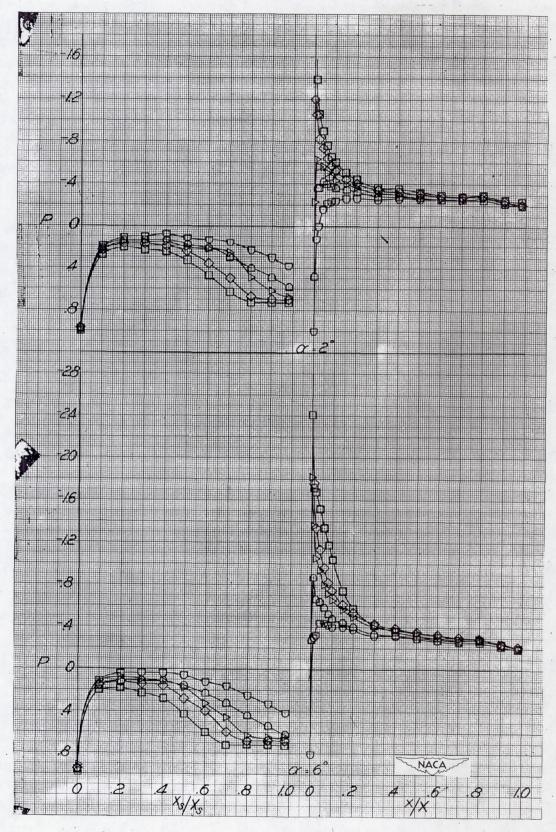


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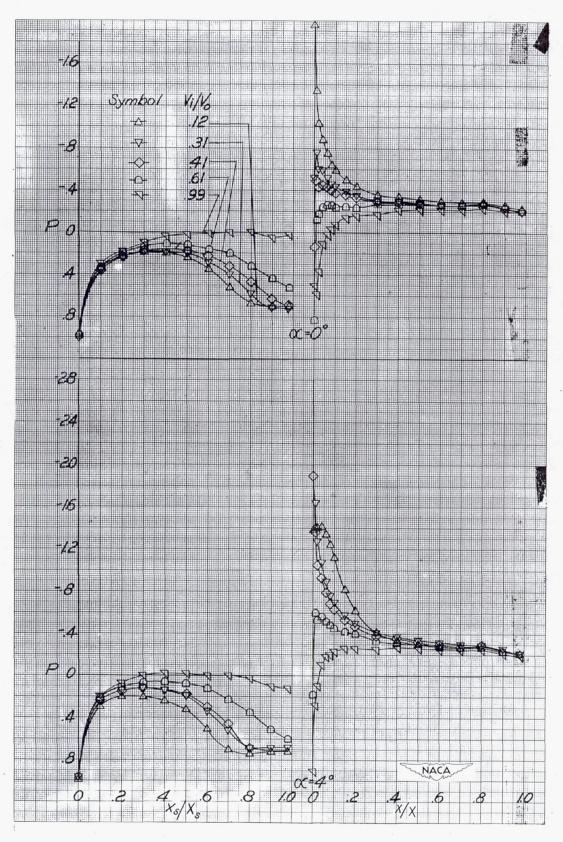


Figure 64.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-40-060 spinner.

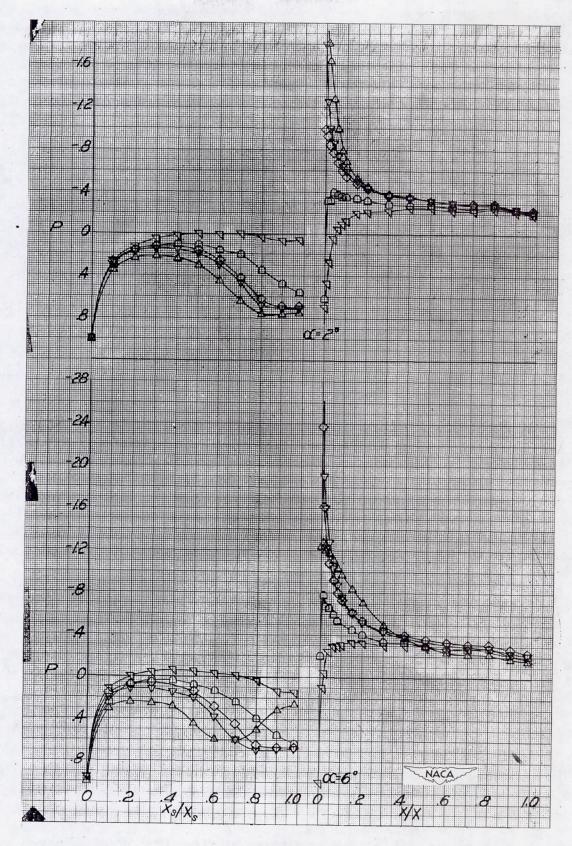


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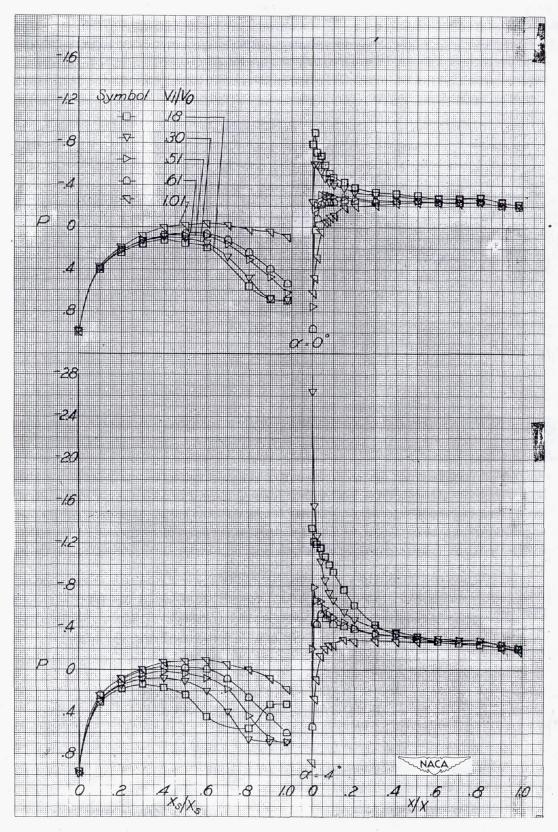


Figure 65.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-50-060 spinner.

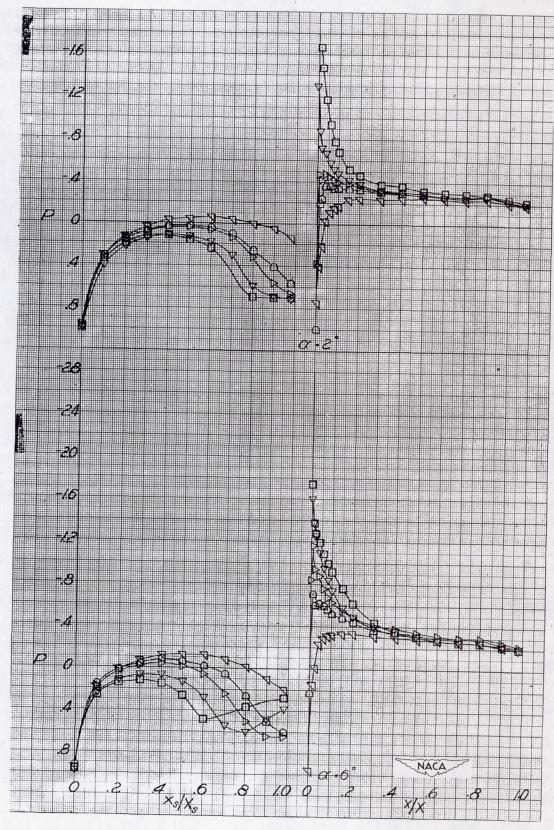


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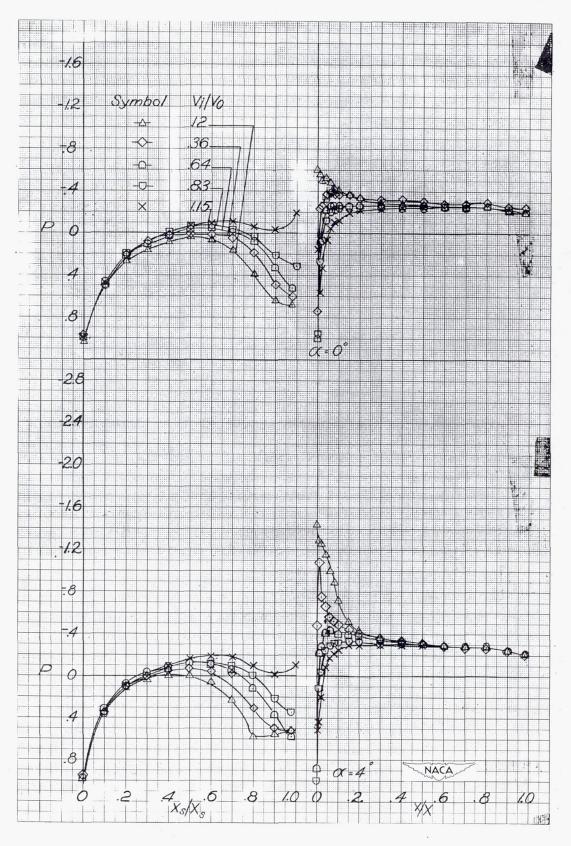


Figure 66.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-60-060 spinner.

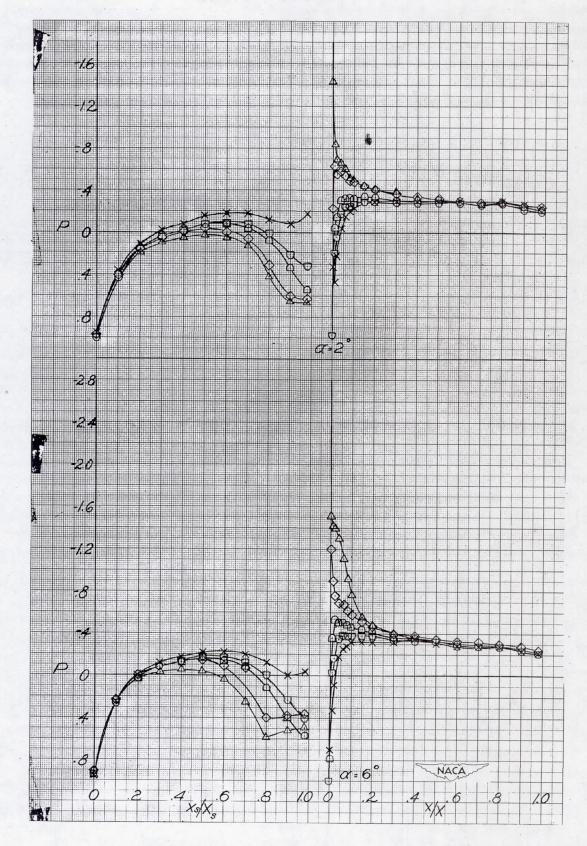


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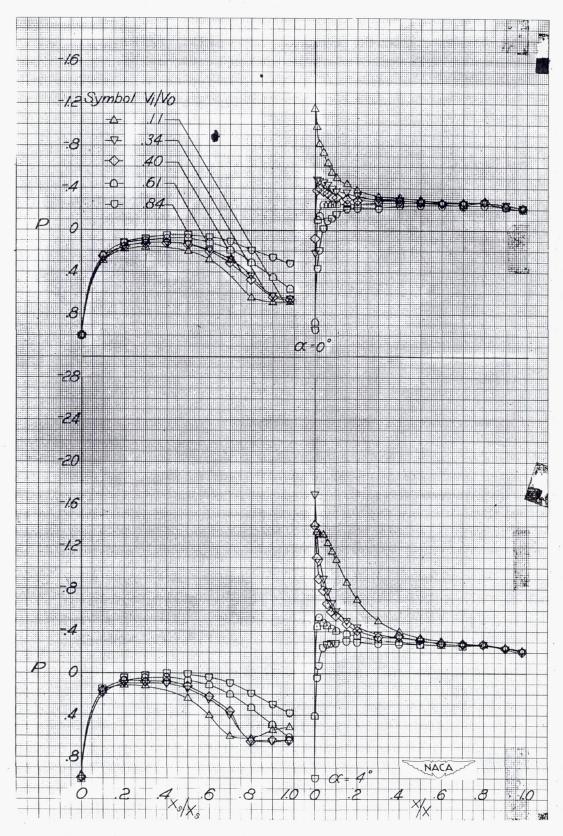


Figure 67.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-40-080 spinner.

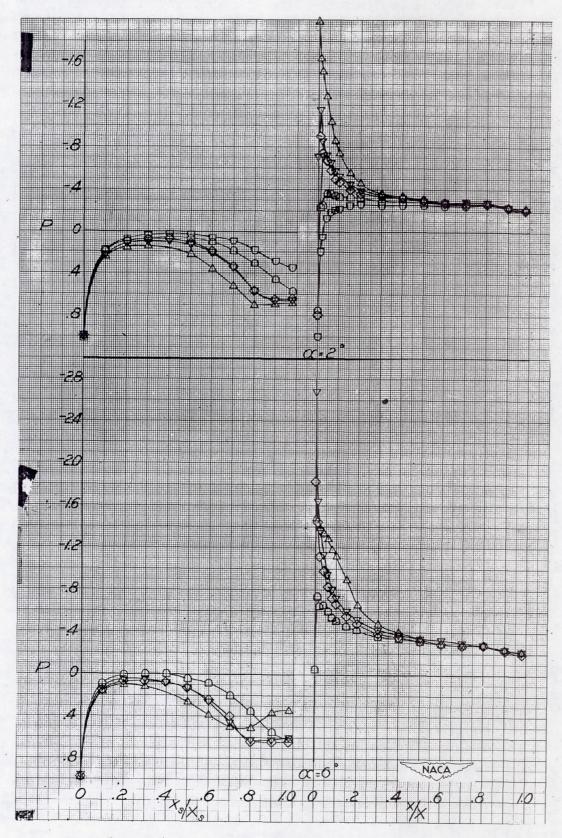


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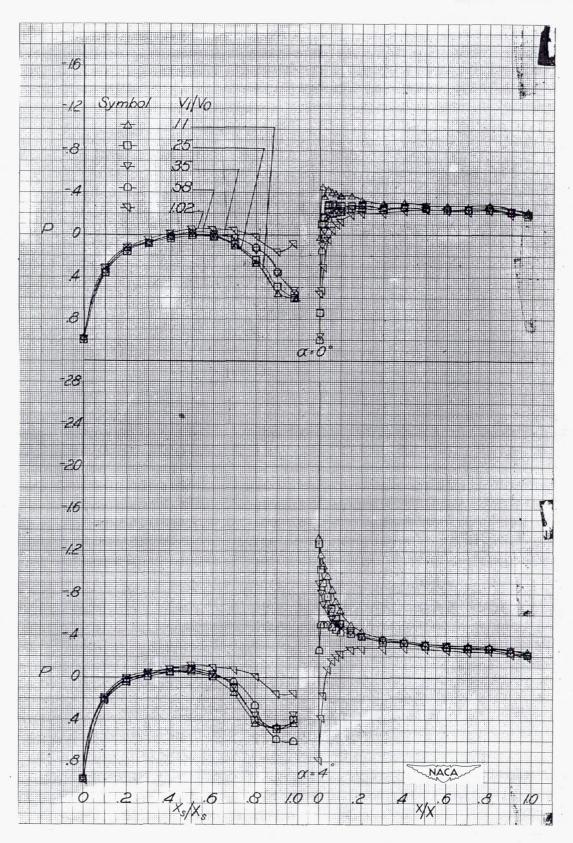


Figure 68.- Static-pressure distributions on top of NACA 1-70-075 cowling with NACA 1-60-080 spinner.

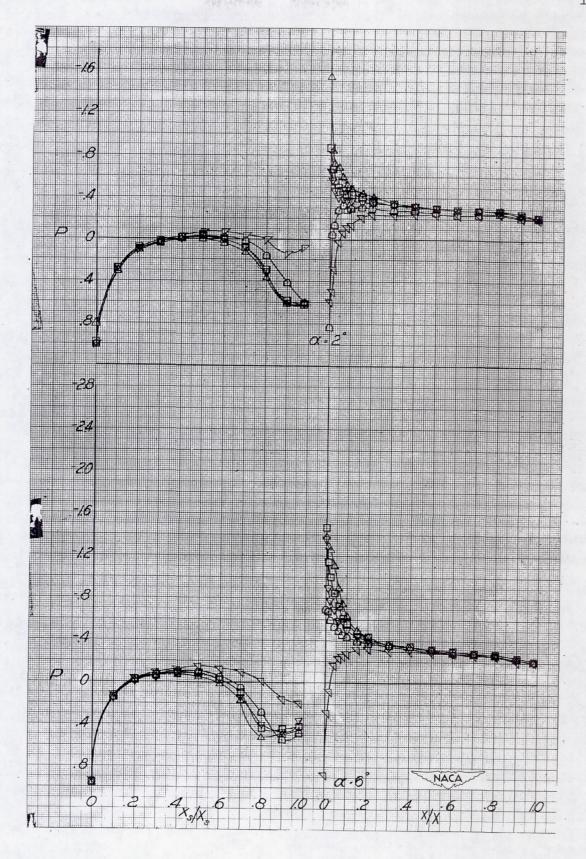


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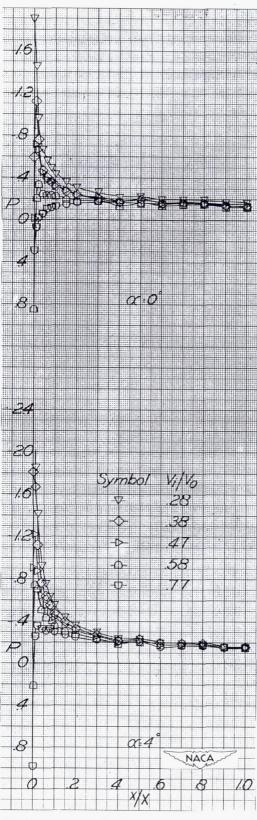


Figure 69.- Static-pressure distributions on top of NACA 1-70-100 open-nose cowling.

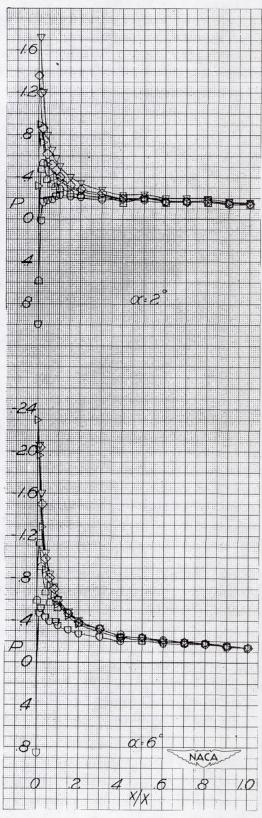


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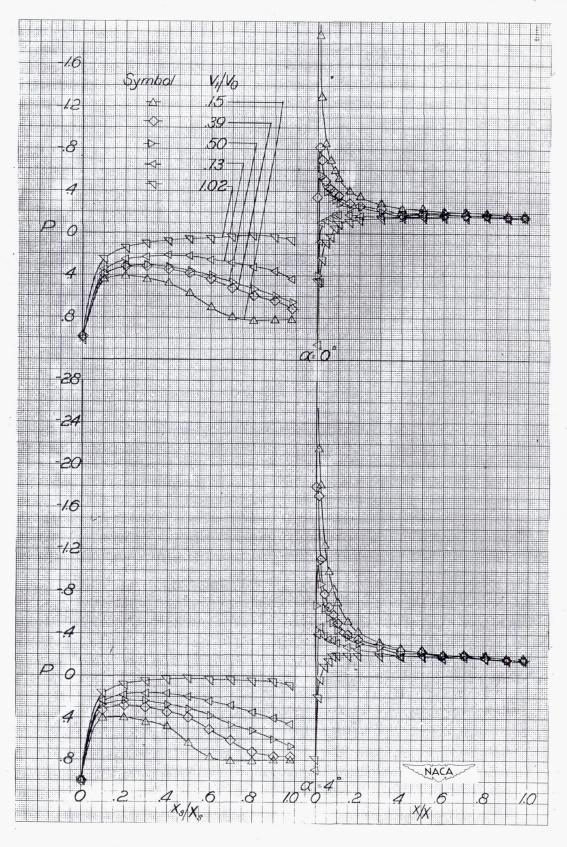


Figure 70.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-20-040 spinner.

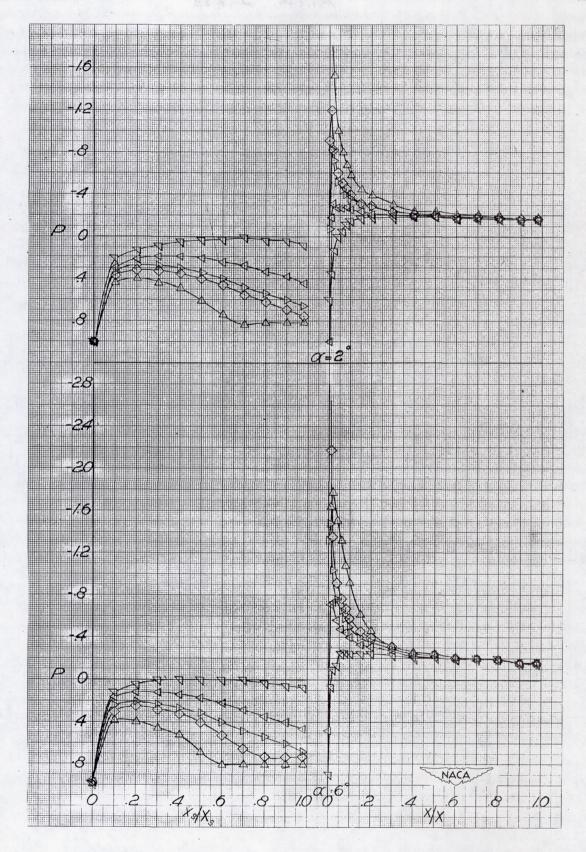


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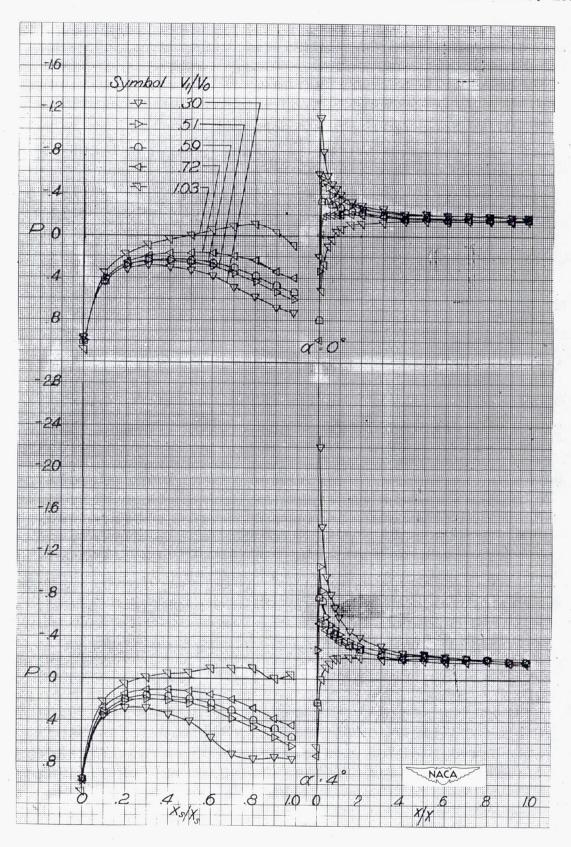


Figure 71.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-30-040 spinner.

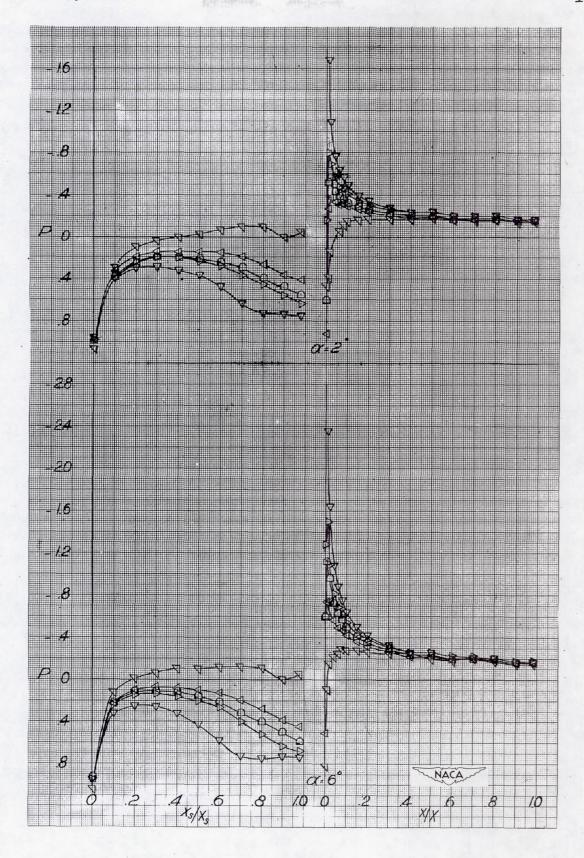


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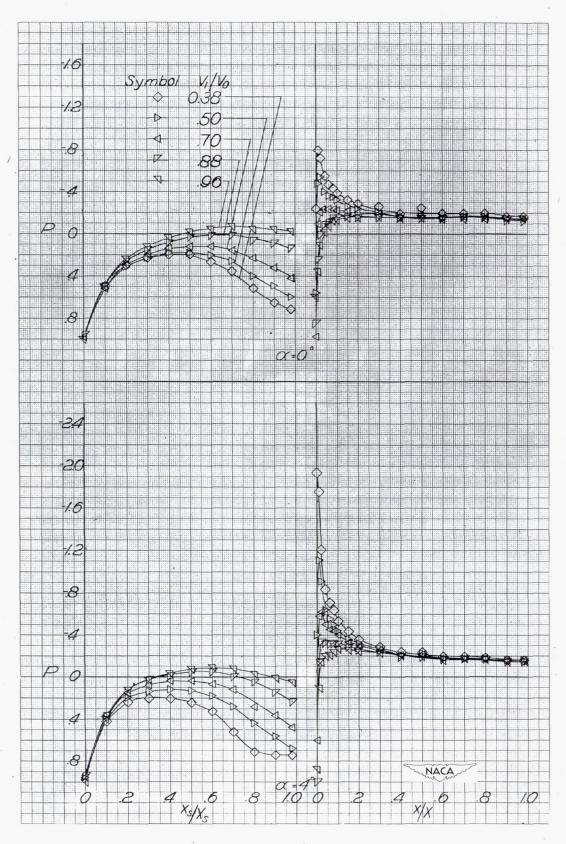


Figure 72.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-40-040 spinner

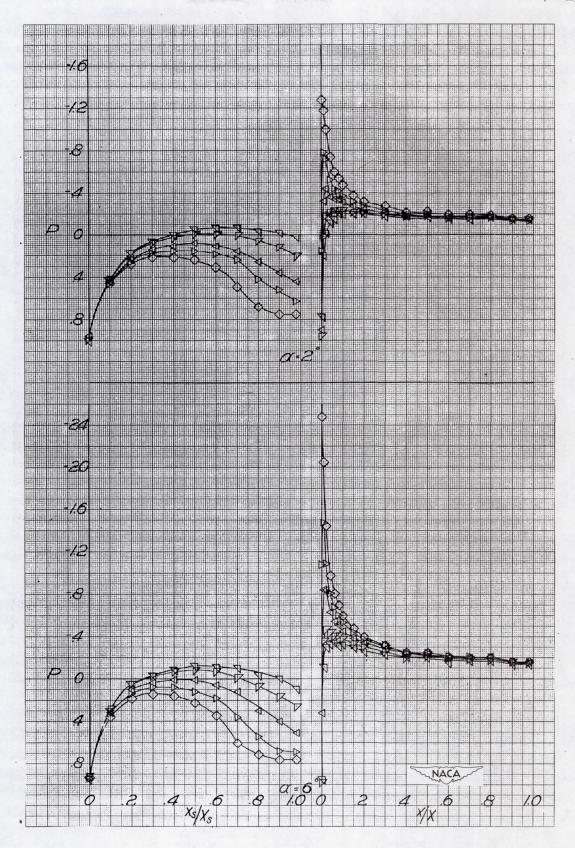


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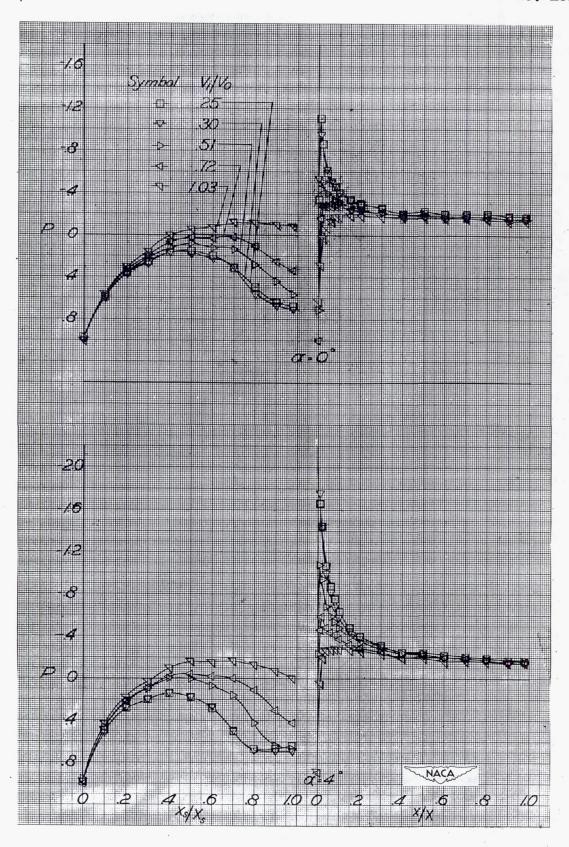


Figure 73.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-50-040 spinner.

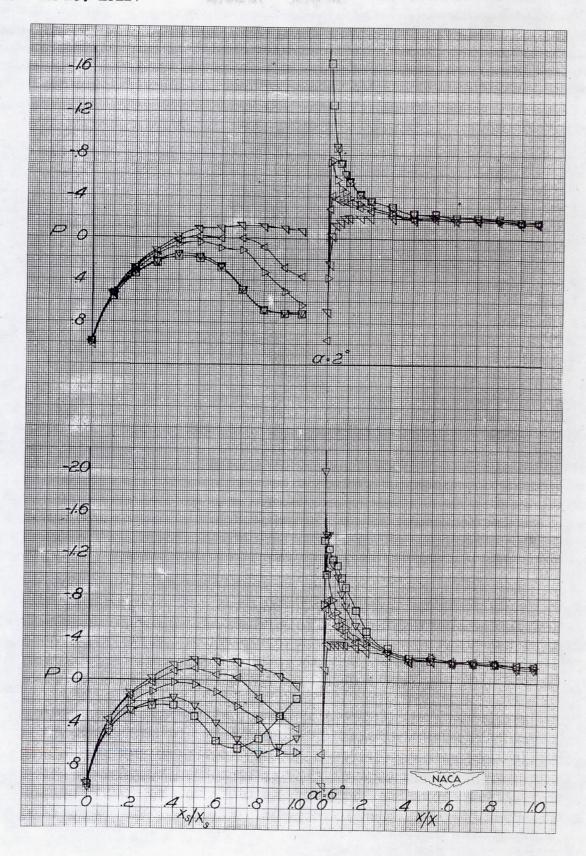


Figure 73.- Concluded.

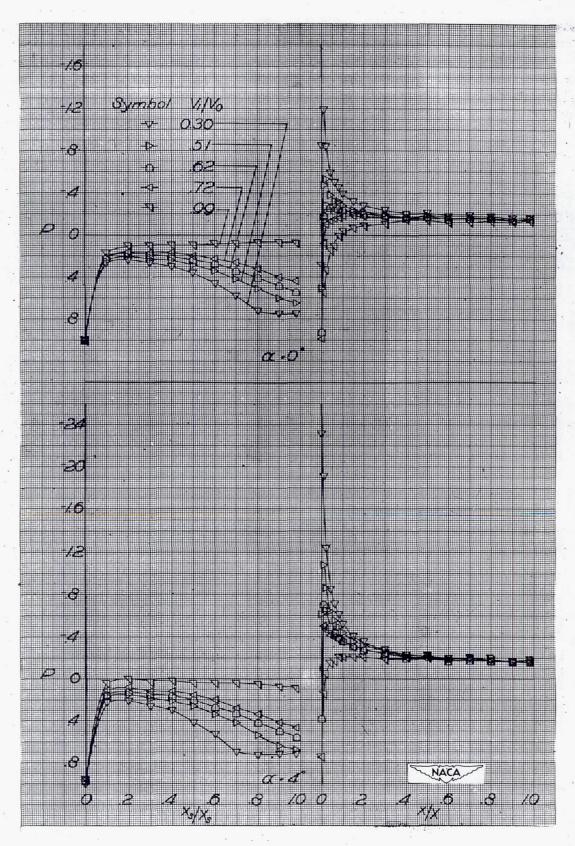


Figure 74.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-20-060 spinner.

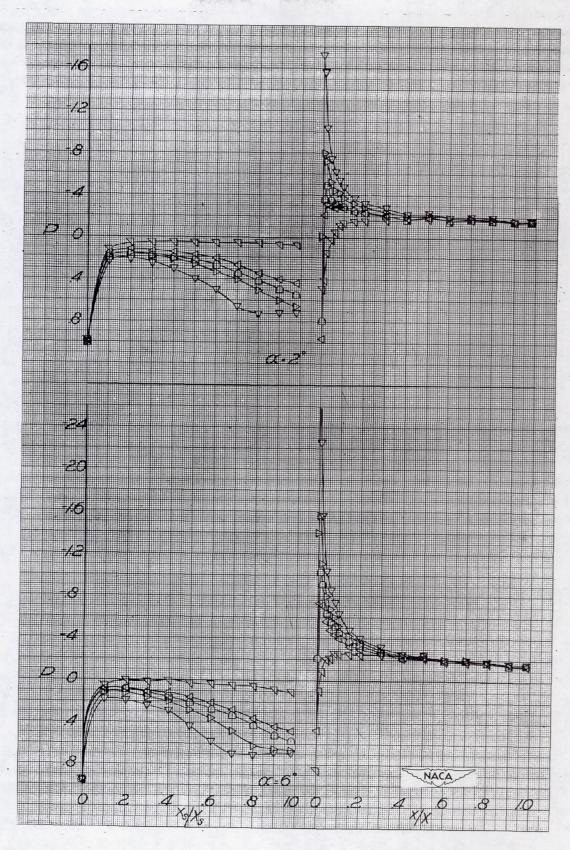


Figure 74.- Concluded.

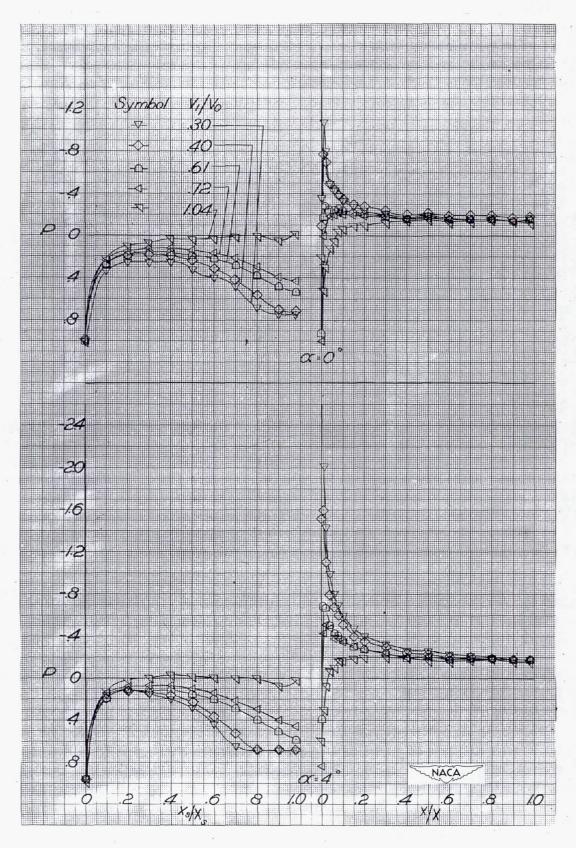


Figure 75.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-30-060 spinner.

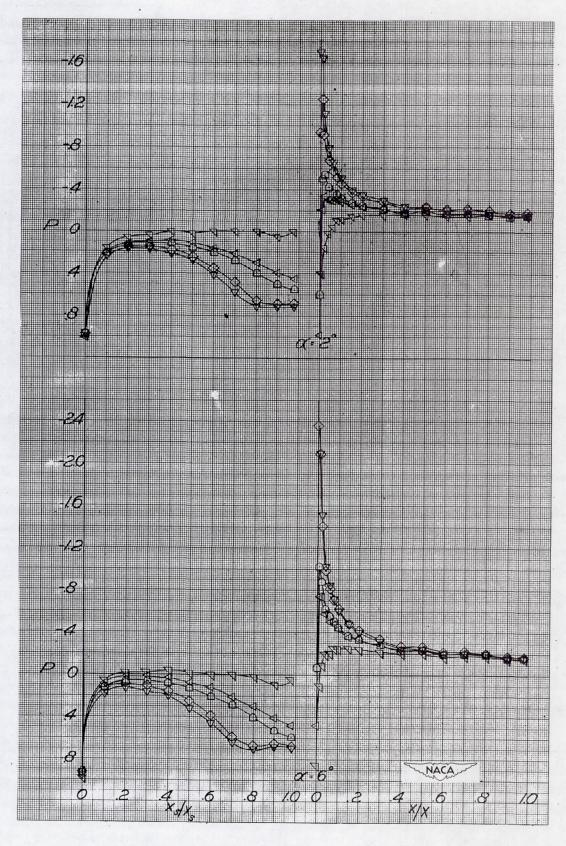


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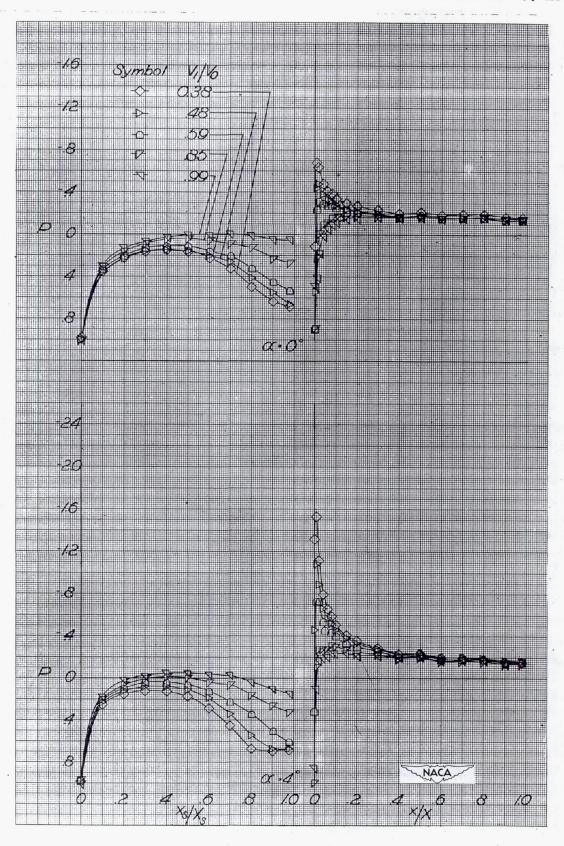


Figure 76.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-40-060 spinner.

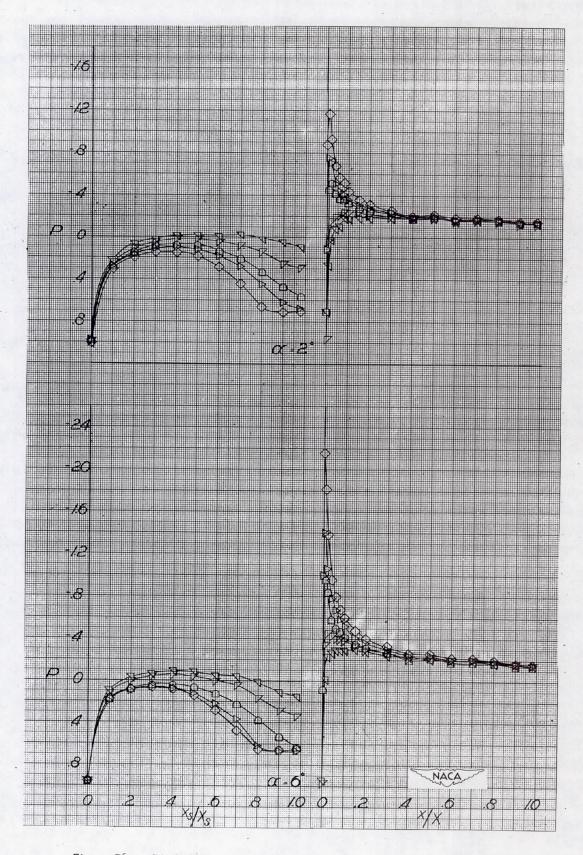


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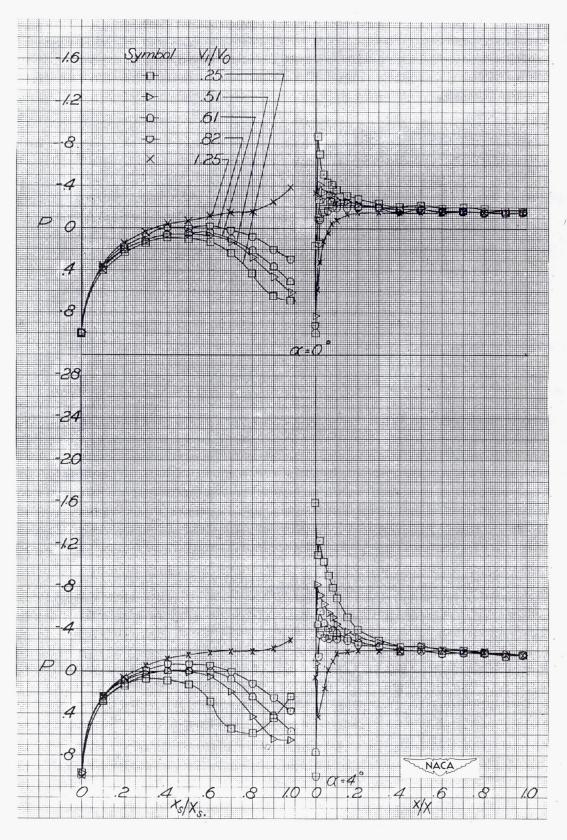


Figure 77.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-50-060 spinner.

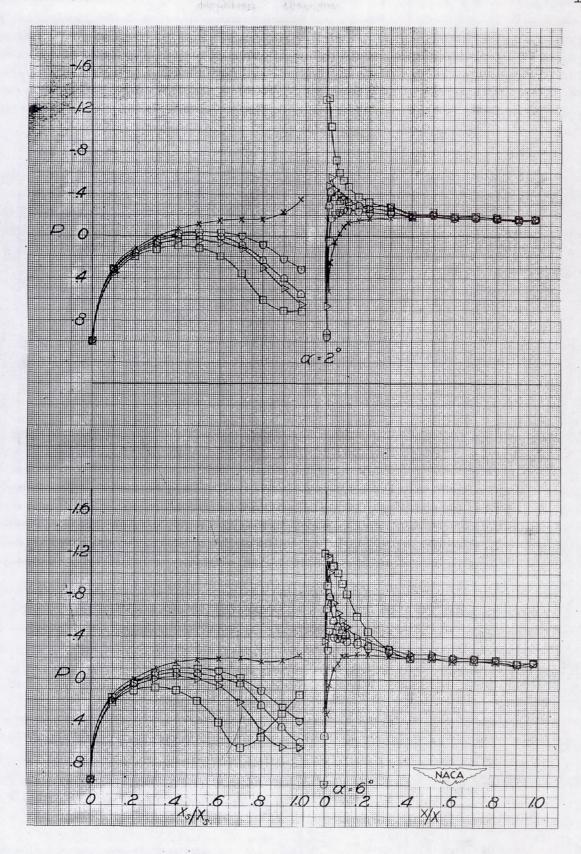


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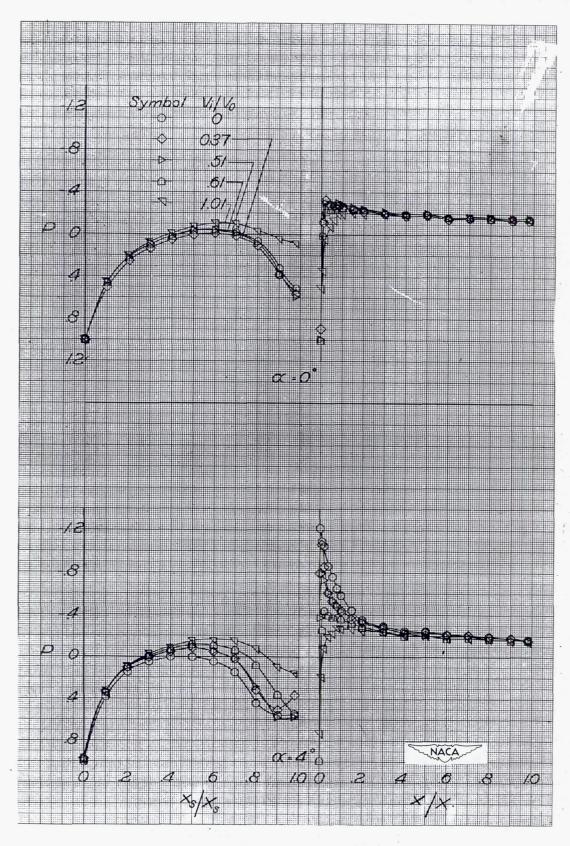


Figure 78.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-60-060 spinner.

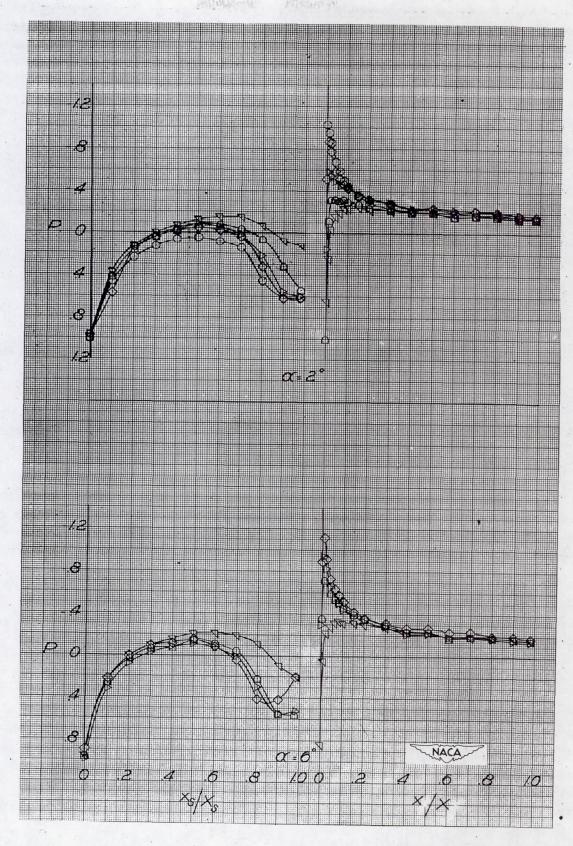


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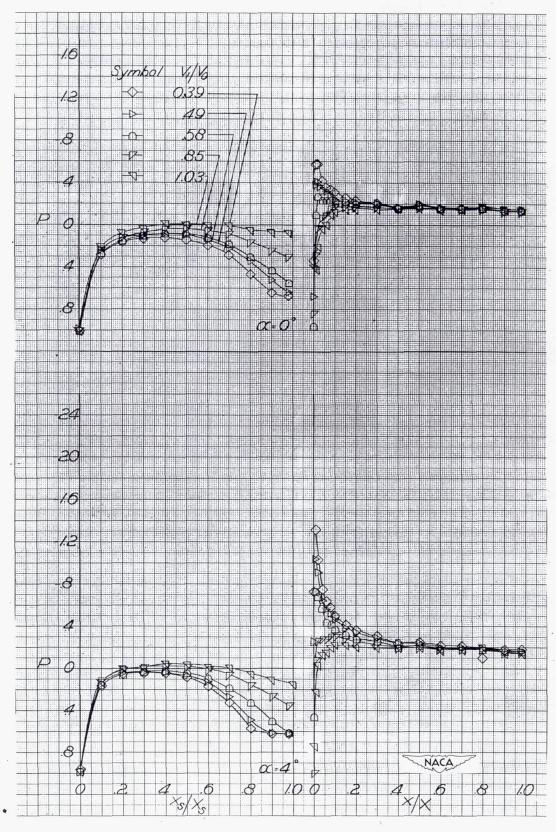


Figure 79.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-40-080 spinner.

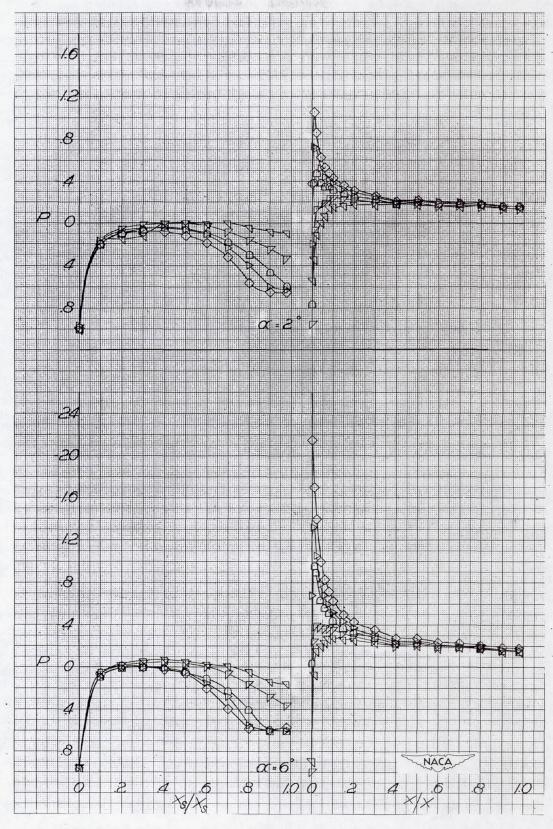


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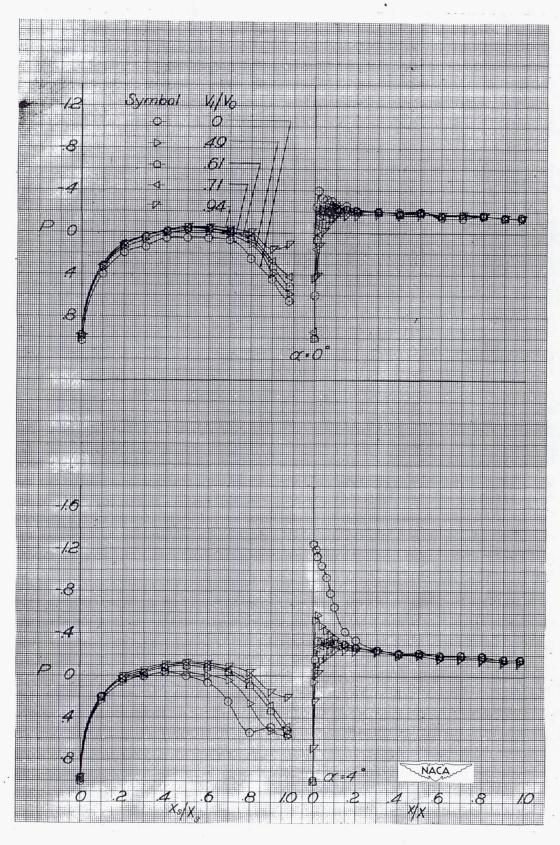


Figure 80.- Static-pressure distributions on top of NACA 1-70-100 cowling with NACA 1-60-080 spinner.

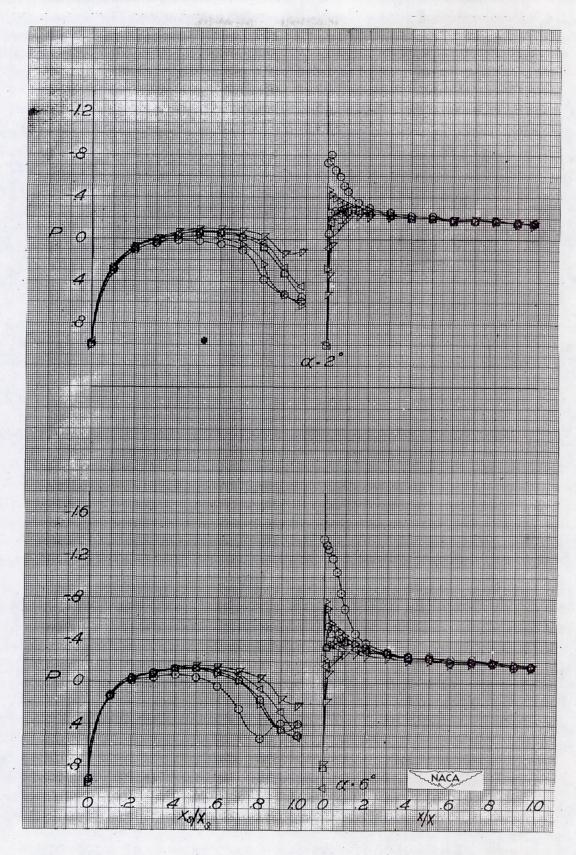


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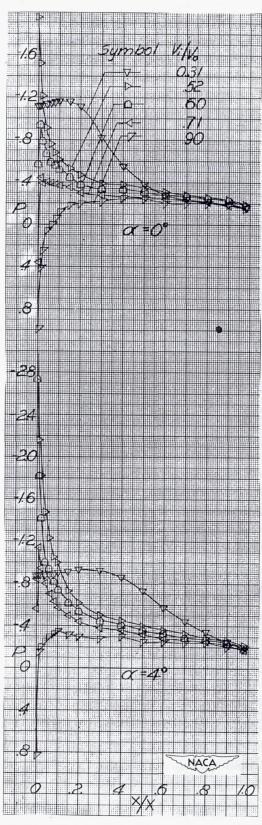


Figure 81.- Static-pressure distributions on top of NACA 1-85-050 open-nose cowling.

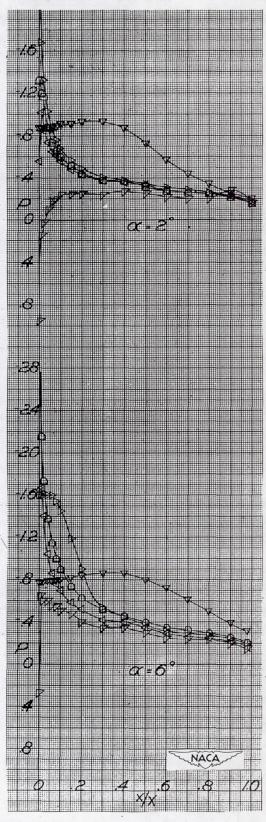


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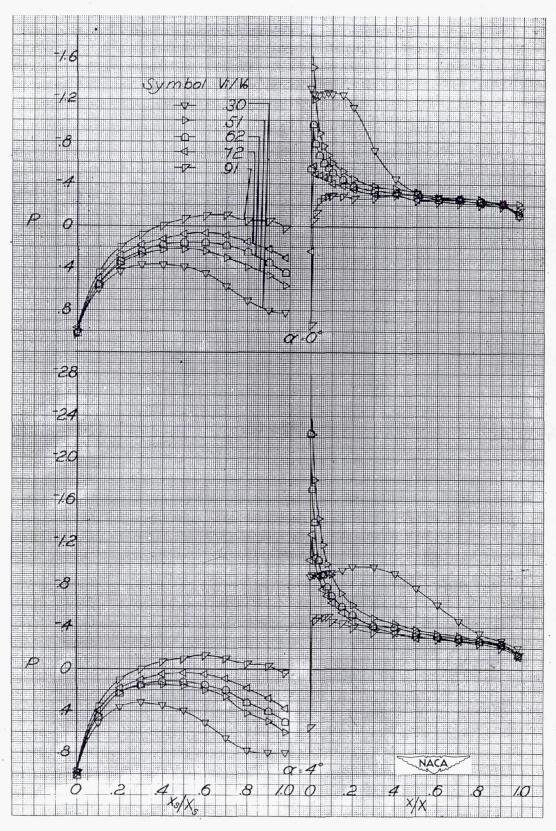


Figure 82.- Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-40-040 spinner.

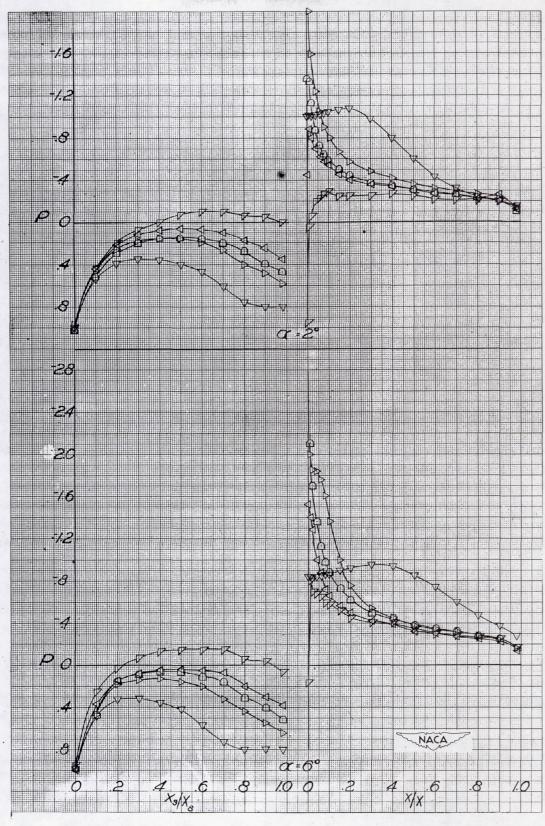


Figure 82.- Concluded.

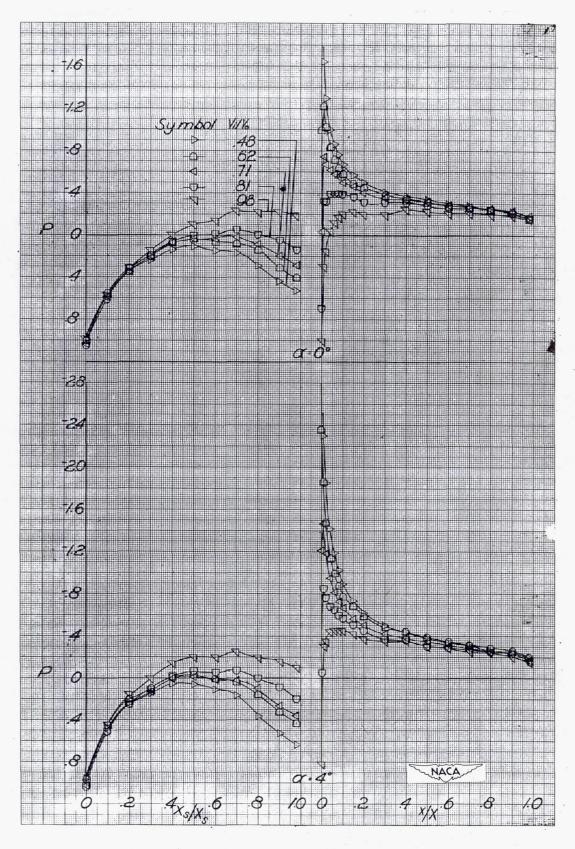


Figure 83. - Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-50-040 spinner.

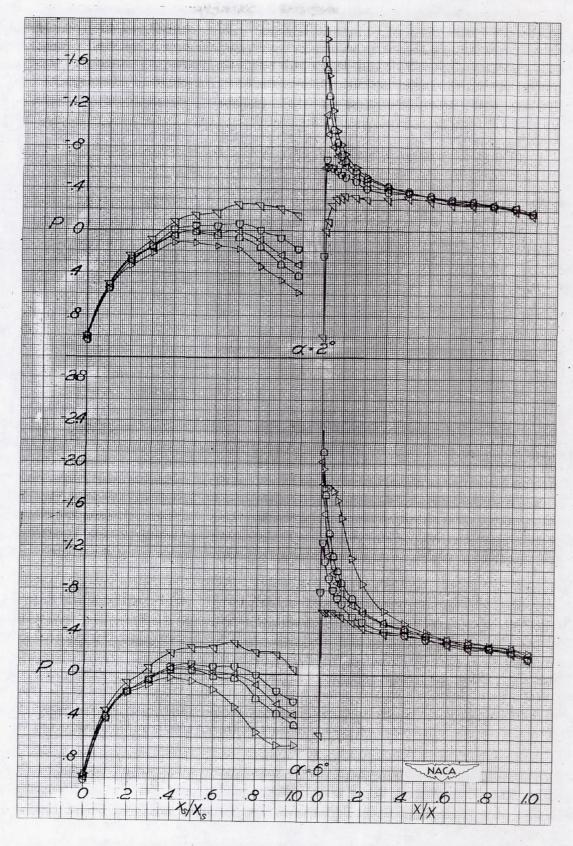


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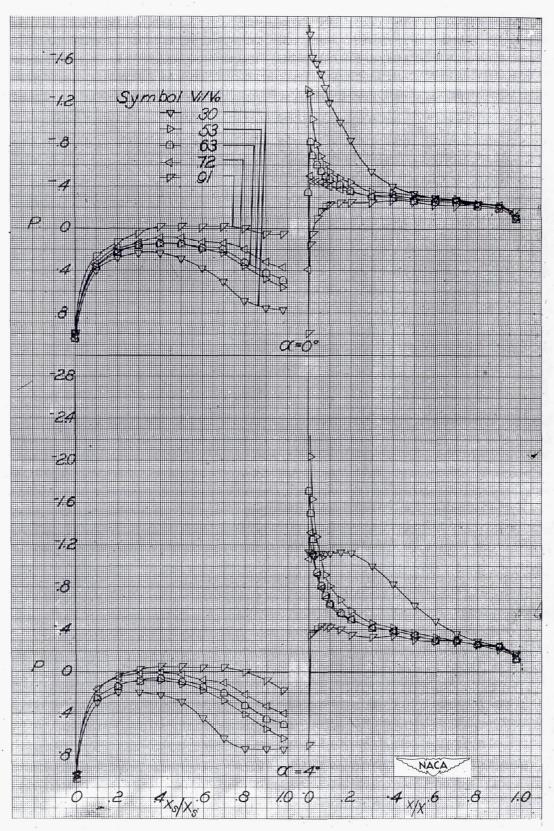


Figure 84.- Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-40-060 spinner.

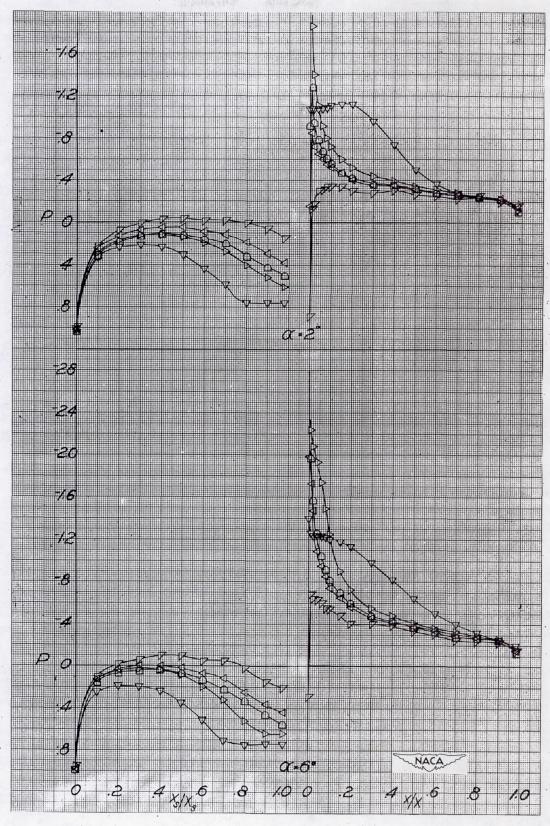


Figure 84.- Concluded.

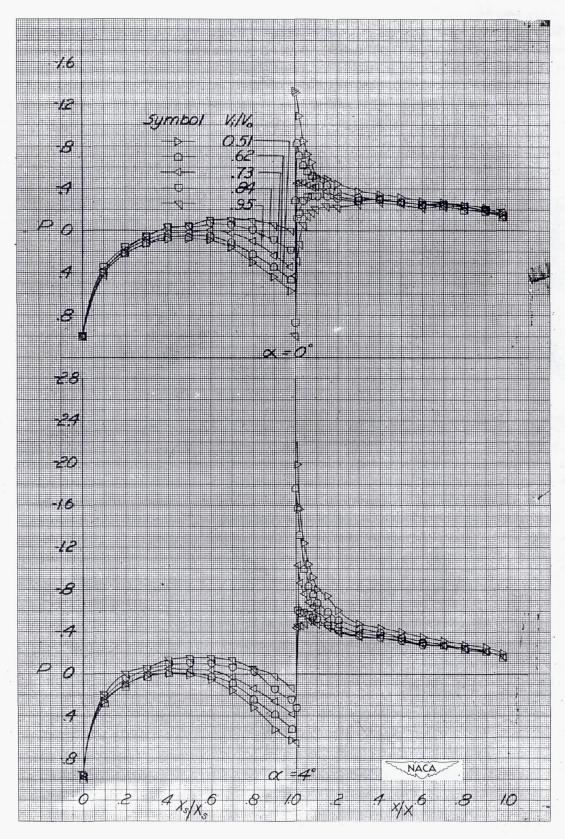


Figure 85.- Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-50-060 spinner.

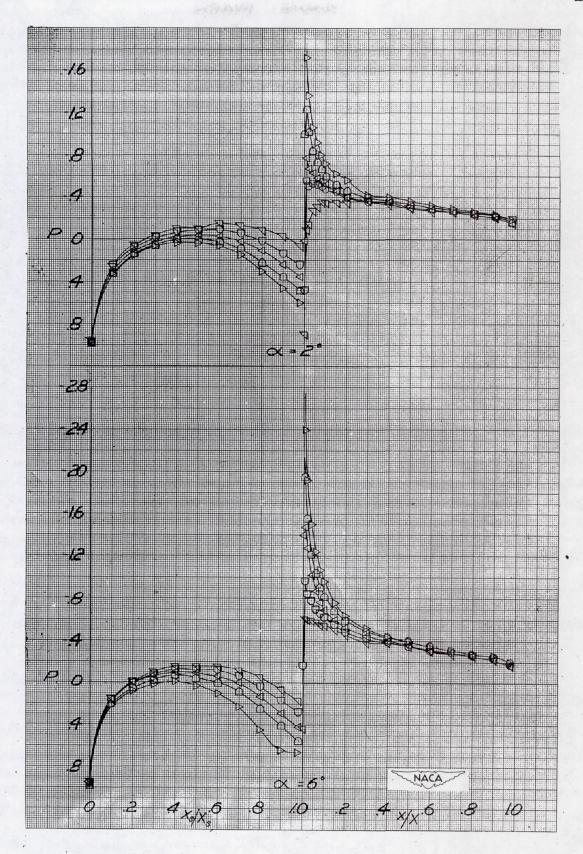


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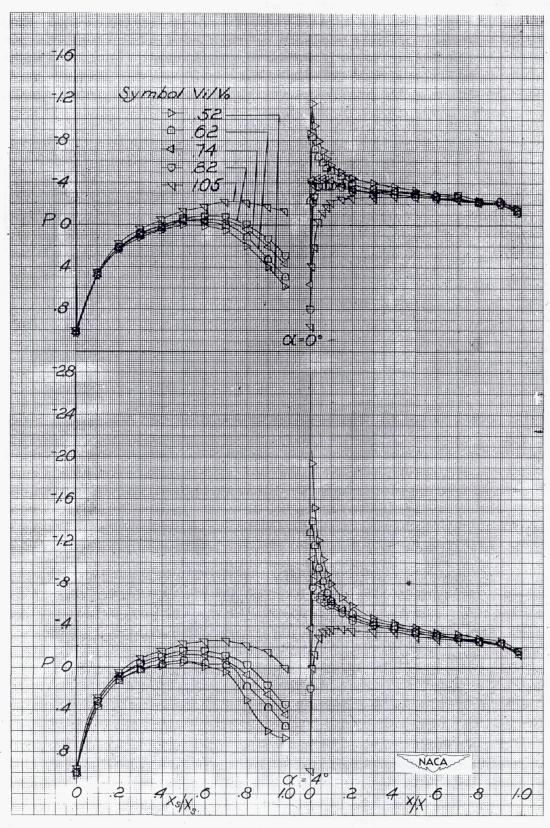


Figure 86.- Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-60-060 spinner.

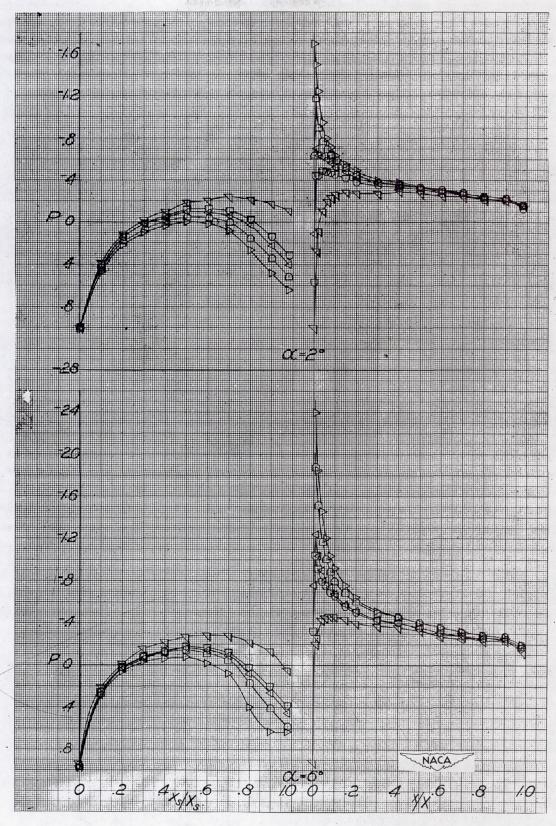


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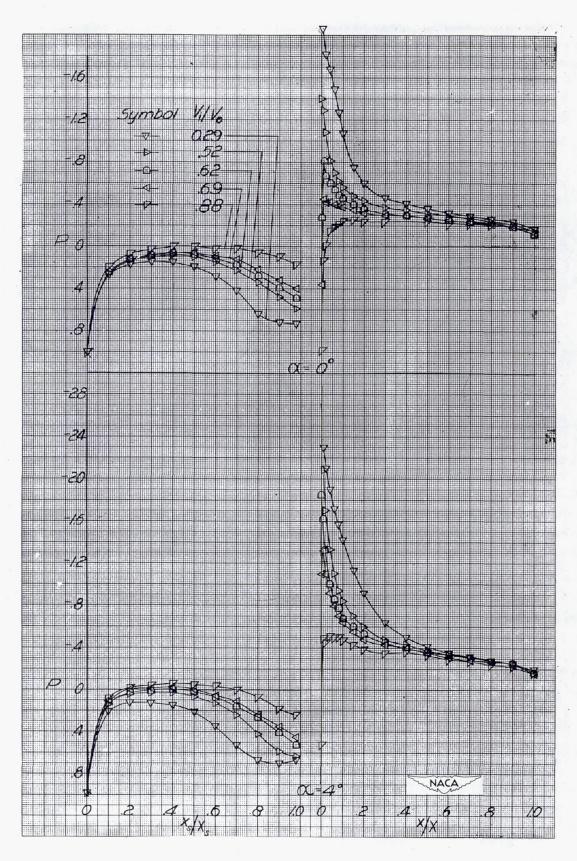


Figure 87.- Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-40-080 spinner.

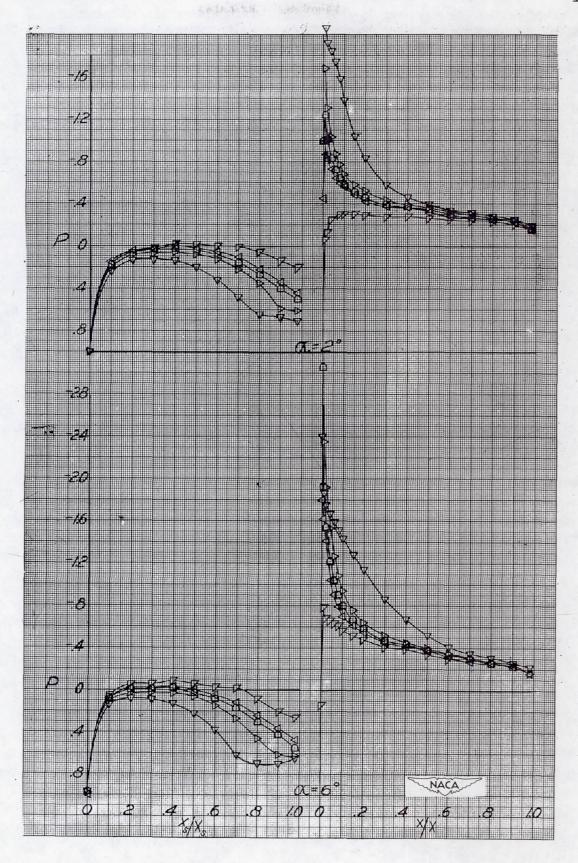


Figure 87.- Concluded.

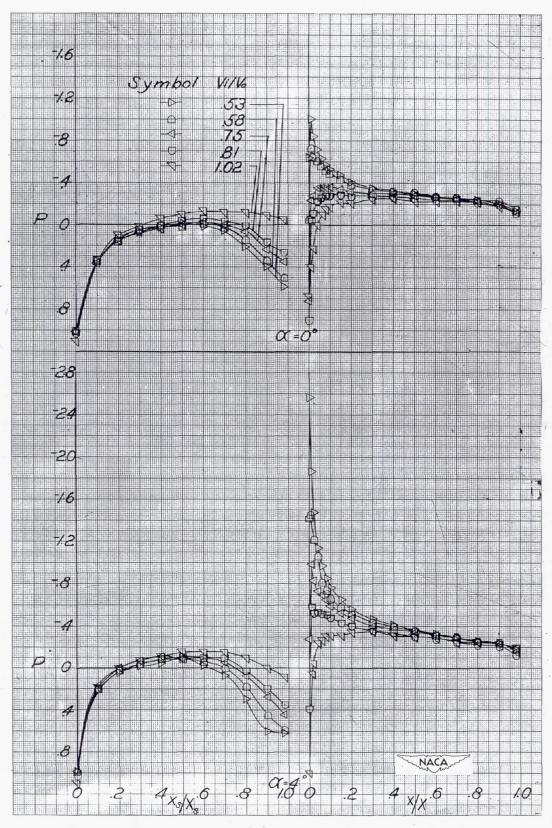


Figure 88.- Static-pressure distributions on top of NACA 1-85-050 cowling with NACA 1-60-080 spinner.

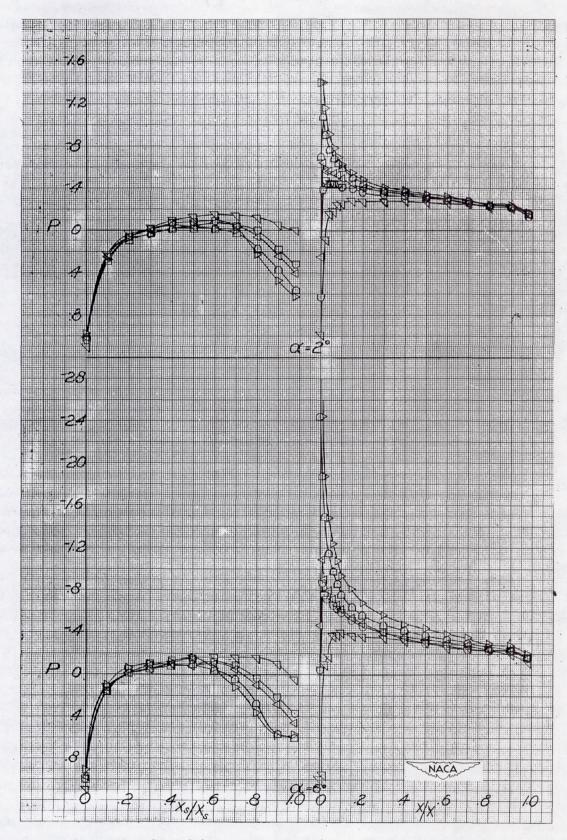
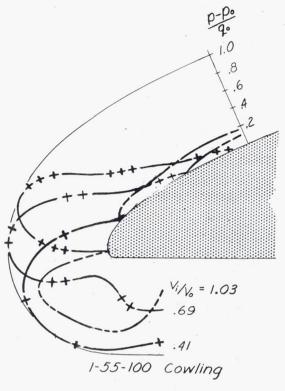
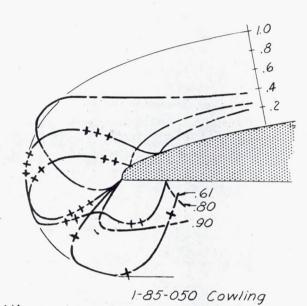
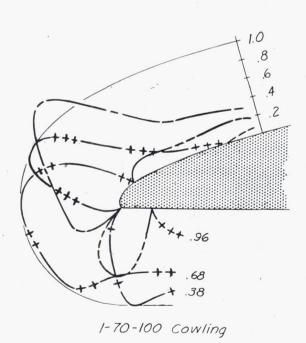


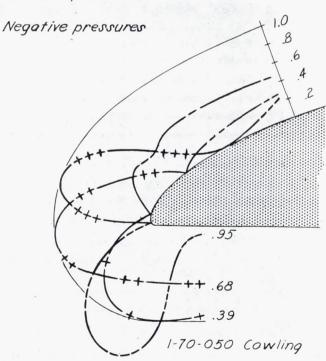
Figure 88.- Concluded.



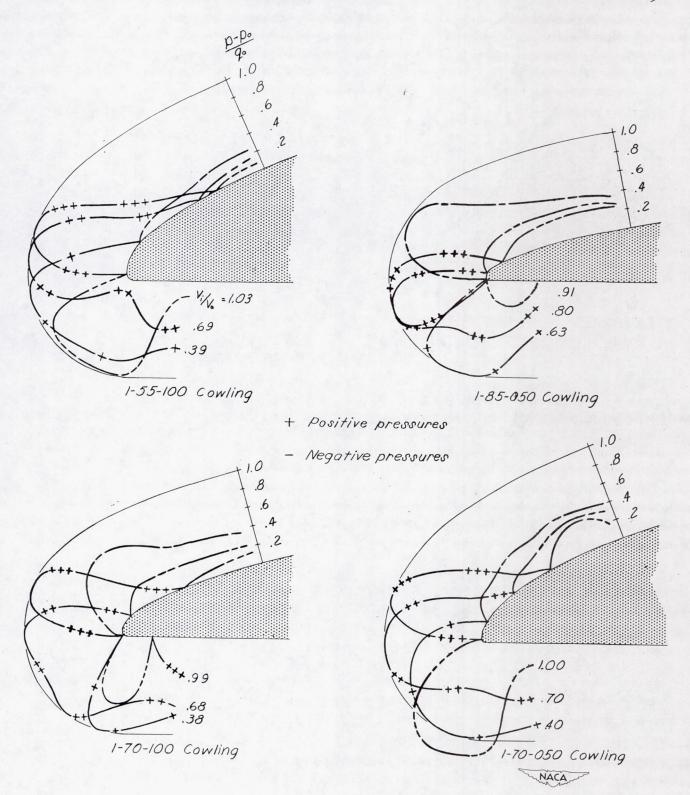


+ Positive pressures

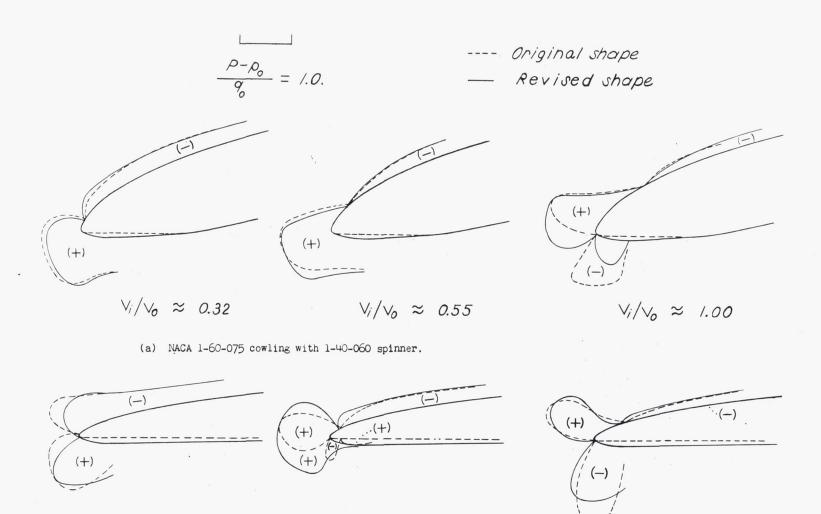




NACA



(b) With 1-40-060 spinner installed. Figure 89.- Concluded.



(b) NACA 1-85-050 cowling with 1-60-080 spinner.

 $V_i/V_o \approx 0.57$

Figure 90.- Effect of inner lip shape on static-pressure distribution around cowling nose. $\alpha = 0^{\circ}$. (Figure taken from reference 3.)

Vi/Vo ≈ 0.90

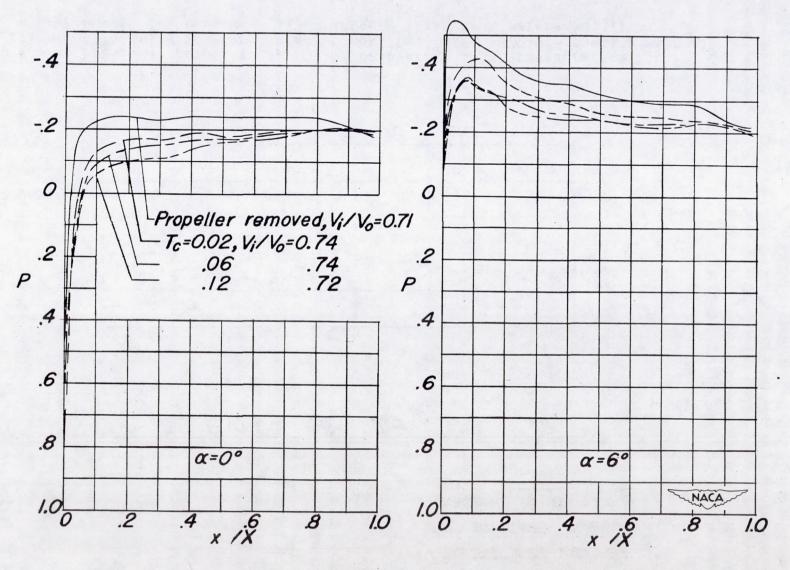
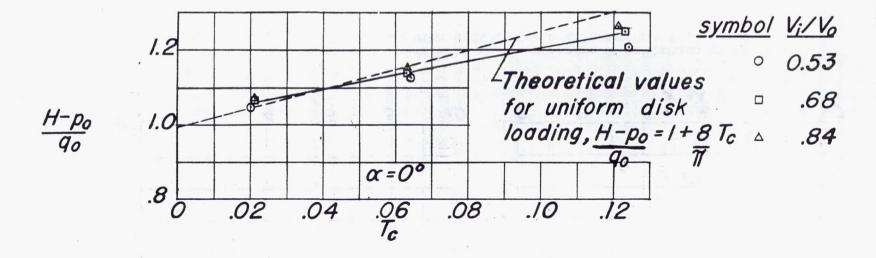


Figure 91.- Effect of propeller operation on static-pressure distribution on top of cowling. NACA 1-70-070 cowling with NACA 1-40-060 spinner; M = 0.13. (Figure taken from reference 3.)





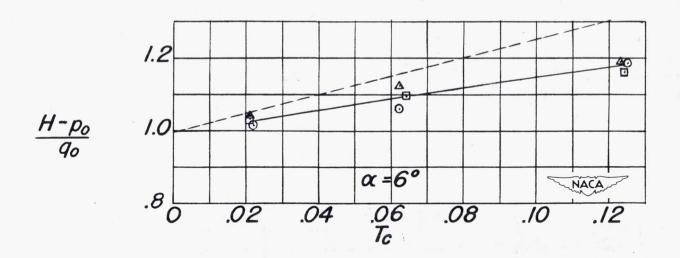


Figure 92.- Effect of propeller operation on average total-pressure coefficient for flow just outside boundary layer of cowling. NACA 1-70-075 cowling with NACA 1-40-060 spinner; M = 0.13. (Figure taken from reference 3.)